Review of Structural Stability

Barre Falls Dam
Connecticut River Basin
Ware River, Massachusetts

NOVEMBER 1982

US Army Corps of Engineers
New England Division

REVIEW OF STRUCTURAL STABILITY

BARRE FALLS DAM

BARRE, MASSACHUSETTS

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASSACHUSETTS

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NOTE: Appendix B is a separate volume

SUMMARY OF REPORT

A stability analysis of the principal concrete structures at Barre Falls Dam was performed to determine whether these structures satisfy current design critiria. The structural elements considered and the qualitative results of the analysis are as listed:

Structure	All Criteria Satisfied
Spillway Weir	Yes
Intake Structure	Yes
Service Bridge Abutment	Yes
Access Bridge Abutment	Yes
Intake Channel Walls	Yes
Spillway Channel Walls	Yes

BARRE FALLS DAM

REVIEW OF STRUCTURAL STABILITY

BARRE FALLS DAM

PART I

GENERAL DESCRIPTION

1.1 Purpose

The objective of this study is to review the stability of the principal concrete structures, based upon current criteria in cases where the original design criteria were less conservative. This review is performed to comply with Corps of Engineers regulation ER-1110-2-100, Periodic Inspection and Continuing Evaluation of Completed Civil Works Structures (30 March 1977).

1.2 Stability Criteria

The current stability criteria by which this project is evaluated are contained in the following Corps of Engineers publications:

Engineering Manuals:

EM 1110-1-2101	Working Stresses for Structural Design, 1 Nov 1963 (with Change 2, 17 Jan 1972)
EM 1110-2-2200	Gravity Dam Design, 25 Sept 1958 (with Change 2, 23 Nov 1960)
EM 1110-2-2400	Structural Design of Spillways and Outlets Works, 2 Nov 1964
EM 1110-2-2501	Wall Design: Flood Walls, Jan 1948 (with Change 3, 18 June 1962)
EM 1110-2-2502	Retaining Walls, 29 May 1961 (with Change 3, 25 Jan 1965)

Engineer Technical Letters:

ETL 1110-2-256	Sliding Stability for Concrete Structures, 24 June 1981

Engineering Regulations:

ER 1110-2-1806	Earthquake Design and Analysis for Corps of Engineers Dams, 30 April 1977

1.4 Project Description

Barre Falls Dam is located on the Ware River, about 0.3 miles below the junction of the East and West Branches of the Ware River in the town of Barre, and 13 miles northwest of Worcester. Construction of the project was initiated in 1956 and completed in May 1958. The dam was operational in December 1957.

The dam consists of a rolled earth rockfill dam, a rock chute-type spillway with concrete ogee weir, 3 dikes located in saddles in the rim of the reservoir, outlet works, storage capacity for flood control.

At spillway crest elevation, 807 feet msl, Barre Falls Reservoir, a dry bed reservoir, has a capacity of 24,000 acre-feet, equivalent to 8.2 inches of runoff from the contributing drainage area of 55 square miles. When filled to spillway crest, the reservoir will have a surface area of about 1,400 acres.

The dam embankment, 885 feet in length and maximum height of 60 feet above streambed consists of rock and earthfill. The top of dam at elevation 830 feet msl provides 18 feet of spillway surcharge and 5 feet of freeboard. A top width of 25 feet accommodates a 16-foot paved access road, and the embankment slopes 1 on 2.0 on the downstream side and 1 on 2.5 on the upstream side of the dam.

There are three dikes, with a maximum height of 48 feet, which total 3,215 feet in length. These dikes constructed of rolled rockfill with an impervious fill upstream blanket, bring elevations up to 830 feet msl in three saddles along the southern rim of the reservoir.

The spillway is located on the right abutment adjacent to the dam. Components of the spillway include the approach channel, discharge channel and a 60-foot long concrete ogee weir with a fixed crest at elevation 807.0 feet msl (46-foot stage).

The outlet works are in the left abutment and consist of an intake channel and a 9'-8" diameter horseshoe conduit. The conduit is 250 feet long and discharges are controlled by two 4.5-foot wide by 9.0-foot high sluice gates controlled from the control tower.

Since the completion of the project, the major impoundments have been:

Year	Month	Max. Water Surface Elev.	Storage (Acre-Feet)	% of Storage Utilized
1960	April	797.9	13,000	55
1962	April	789.0	5,500	23
1968	March	788.8	5,400	22
1977	March	786.1	3,950	16
1976	January	785.3	3,420	15

1.5 Pertinent Hydraulic Data

The hydraulic data used for this review of structural stability are as follows:

Full Pool Condition - Reservoir at spillway crest elevation 807.0; no downstream tailwater in outlet channel.

Design Discharge Condition - Reservoir at spillway design flood maximum surcharge elevation 822.0; downstream tailwater in outlet channel at elevation 810.00.

1.6 Discussion of Analysis and Criteria

The principal structural elements analyzed for stability consist of the following:

(a) Spillway Weir

(b) Intake Structure

(c) Service Bridge Abutment

(d) Access Bridge Abutment

(e) Intake Channel Walls

(f) Approach Channel Walls

Sliding stability of structures subjected to lateral loadings is assessed by the criteria presented in ETL 1110-2-256. The adequacy of sliding resistance is evaluated by determining a safety factor that is applied to the resisting shearing forces in a manner which places the forces acting on the structure in sliding equilibrium. For all of the structures analyzed, except for the spillway training walls, a minimum factor of safety of 2.0 is required for all conditions of loading when earthquake is not considered. For loading conditions where earthquake is considered, this factor of safety should exceed 1.3. The spillway training walls should have a factor of safety greater than 1.5 for all loading conditions. Sliding stability was analyzed by the "Sliding Resistance Method" (ratio of horizontal forces to vertical forces less than 0.65) in the original design computations made in 1955.

The resistance to overturning is determined according to current criteria by the location of the resultant of vertical forces at the base. The resultant should be located within the middle third of the base for all conditions of loading when earthquake is not considered. For loading conditions where earthquake is considered, it is acceptable if the resultant stays within the base, provided that allowable foundation pressures are not exceeded. For retaining walls founded on rock, the resultant may be outside the middle third, but within the base, if

foundation pressures are within allowable values and the factor of safety against sliding is adequate. There have been no significant changes in overturning criteria since the original computations were made.

Barre Falls Dam is located in Seismic Zone 2 (moderate damage) as shown on the Seismic Zone Map of Contiguous States, included with ER 1110-2-1806. Therefore, this analysis takes into account earthquake forces induced by accelerations equal to 0.05g. Earthquake forces were not always considered in the original design computations.

In accordance with EM 1110-2-2200, the seismic forces applied to this stability analysis are as follows:

(a) Inertia force Pe_1 due to acceleration of the structure, acting through the center of gravity in any direction. $Pe_1 = 0.05W$, where W is the weight of the structure.

(b) Inertia force Pe_2 induced by the impoundment of water. This force is computed using Westergaard's formula and the following parameters are used throughout: acceleration equal to 0.05g, period of vibration equal to 1 second.

(c) Dynamic earth pressure, as outlined in EM 1110-2-2502, is accounted for by adding the weight of backfill between a sloping wall and a vertical plane through the heel to the wall weight for computation of inertia force Pe_1.

No vertical acceleration is considered in this analysis. Uplift is assumed to be unaffected by earthquake accelerations.

The uplift pressure at any point under a structure is the tailwater pressure plus the pressure measured as an ordinate from tailwater to the hydraulic gradient between the upstream and downstream pool. Uplift pressure is considered to act over 100 percent of the base area.

Ice pressure of 10,000 pounds per lineal foot of structure is applied in this analysis in accordance with EM 1110-2-2200. Ice pressure was not considered in the original computations.

Wind pressure of 30 pounds per square foot is used in this stability investigation and in the original computations.

1.7 Discussion of Foundations and Foundation Parameters

All of the structural elements considered in this stability analysis, except for the service bridge abutment, are founded on rock. As described in the Definite Project Report - Barre Falls Dam, the bedrock formation underlying the dam site consists of relatively unweathered schist and granite. The service bridge abutment is founded in the random fill of the dam. The spillway weir is mechanically anchored to the foundation, but

because the condition of this anchorage system is unknown it was assumed not to exist for analysis purposes.

Allowable bearing pressures on the foundation materials described above are not given in the original design computations. An allowable bearing pressure of 20 tons per square foot on bedrock and 2.0 tons per square foot on overburden and random fill is assumed in this analysis.

The shear strength of the foundation materials is computed using the Mohr-Coulomb failure criteria as described in ETL 1110-2-256. Throughout this analysis, the critical potential failure surface for sliding stability is assumed to be a single plane at the interface of concrete structure and foundation material.

All of the structural elements analyzed, except for the spillway weir, are subjected to lateral forces induced by earth backfill. Earth pressures acting on the service bridge abutment are considered to be active pressures. Earth pressures acting on the remaining structures, all founded on rock, are considered to be at-rest pressures in accordance with EM 1110-2-2502.

Foundation parameters used for this analysis are as follows:

(a) Allowable bearing pressure on bedrock = 20 tons per square foot (assumed value).

(b) Allowable bearing pressure on overburden or random fill = 2.0 tons per square foot (assumed value).

(c) Shear at interface between rock and concrete = 80 pounds per square inch (based on ACI 318-71, composite concrete, allowable bond shear stress for clean and intentionally roughened contact surfaces without mechanical anchorages).

(d) Coefficient of frictional resistance = 0.5 (concrete on rock), 0.45 (concrete on overburden or random fill).

(e) Coefficient of active earth pressure = 0.27 (based on internal angle of friction = 35° and corrected, where necessary, to account for sloping backfills).

(f) Coefficient of at-rest earth pressure = 0.5 and corrected, where necessary, to account for sloping backfills.

1.8 Method of Computation

Stability analysis of the spillway weir was performed using the computer program "DAMPAC," developed by the Corps of Engineers, New England Division. "DAMPAC," Corps of Engineers Program No. 713 F5 DO 100 and 105, is a fully documented design package for stability analysis of concrete gravity dams.

Stability of all other structures was investigated by manual calculations.

PART II

RESULTS OF THE ANALYSIS

2.1 Spillway Weir.

The spillway weir is an ogee-shaped concrete structure founded on bedrock. The weir is approximately 60-feet long and consists of two monoliths. A typical section at elevation 798.0 at the interface of rock and concrete was analyzed. At elevation 798.0 the section analyzed has a height of 9.0 feet and a base length of 25.41 feet.

As outlined in EM 1110-2-2200, the loading conditions which were considered for the analysis of the spillway weir are as follows:

Case I. Construction Condition. Spillway completed but no water in reservoir, no tailwater, wind load on downstream face.

Case II. Normal Operating Condition. Pool elevation at spillway crest. Minimum tailwater. Ice pressure.

Case III. Induced Surcharge Condition. Pool elevation at top of partially opened spillway gate. (This case is not applicable to this analysis because the spillway at Barre Falls Dam is ungated).

Case IV. Flood Discharge Condition. Reservoir at maximum flood pool elevation. Tailwater at flood elevation. Tailwater pressure at 60 percent of full value, except that full value is used for computation of the uplift. No ice pressure.

Case V. Construction Condition with Earthquake. Earthquake acceleration in a downstream direction (thus directing inertia forces upstream). No water in reservoir. No wind load. No tailwater.

Case VI. Normal Operating Condition with Earthquake. Earthquake acceleration in an upstream direction (thus directing inertia forces downstream). Reservoir at spillway crest. Minimum tailwater. No ice pressure.

For Load Cases I through IV, stability criteria are satisfied if the resultant falls within the middle third of the base and the factor of safety against sliding is greater than 2.0. For Load Cases V and VI, stability criteria are satisfied if the resultant stays within the base, provided that allowable foundation pressures are not exceeded, and the factor of safety against sliding is greater than 1.3.

TABLE 1

STABILITY ANALYSIS OF SPILLWAY WEIR

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Rock KIPS/S.F. Toe	Bearing Pressure on Rock KIPS/S.F. Heel
Typical Sect.	I	Yes	-	1056.	25.25	1.31	.65
At Elev. 798.0	II	Yes	-	22.5	25.25	.06	1.44
Ht. = 9.0'	III	Load Case III Not Applicable					
Base = 25.25'	IV	Yes	-	29.4	25.25	.01	.30
	V	Yes	-	114.8	25.25	1.39	.58
	VI	Yes	-	53.3	25.25	.72	.78

(1) See Plates 4 and 5 for details.
(2) Factor of safety computed with cohesion value of 80 psi and coefficient of friction of 0.5.

2.2 Intake Structure

The intake structure is a monolithic tower consisting of a control house, shaft and gated water passage. The height of the reinforced concrete structure from the roof top of the control house to the bottom of the base slab (El. 758.0) is 94.83 feet. Due to the position of the intake structure, it was determined that stability in only the upstream-downstream direction need be investigated.

As outlined in EM 1110-2-2400 (2 Nov 1964), the loading conditions which were considered for analysis of the intake structure are as follows:

Case I. Reservoir empty. Wind load to produce most severe foundation pressures.

Case II. Gate structure with all gates open. Reservoir at spillway crest. Ice pressure. Uplift. Water surface inside structure drawn down to hydraulic gradient with all gates open.

Case III. Similar to Case II, except that gate structure operating with one ouside gate closed, others open.

Case IV. Gate structure with gates closed. No flow in conduits. Reservoir at spillway crest. Ice pressure. Uplift. Structure full of water upstream from closed gates.

Case V. Reservoir raised to spillway design flood level for whichever of preceding Cases II, III, or IV is most critical. No ice pressure. (For this analysis, Case II is most critical.)

Case VI. Bulkheads in place. Reservoir at maximum level at which bulkheads are used. (For this analysis, reservoir at El. 796.0)

Case IA, IIA, IIIA, or IVA. Same as Case I, II, III, or IV, respectively, with earthquake load added, except that earthquake is substituted for wind in Case IA, and for ice in the other cases. (The water in the gate structure was added to the mass of the structure for computation of inertia forces.)

For Load Cases II, III, IV and VI, stability critiera are satisfied if the resultant falls within the middle third of the base and the factor of safety against sliding is greater than 4.0. For Load Cases I and V, stability criteria are satisfied if 75 percent of the base is in compression and the factor of safety against sliding is greater than 4.0. For Load Cases IA, IIA, IIIA, and IVA, stability criteria are satisfied if the resultant stays within the base, provided that allowable foundation pressures are not exceeded, and the factor of safety against sliding is greater than 2.67.

The results of the stability analysis of the intake structure are contained in Table 2. Stability criteria are satisfied for all the specified loading condition.

TABLE 2

STABILITY ANALYSIS OF INTAKE STRUCTURE

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Rock KIPS/S.F. Upstream	Bearing Pressure on Rock KIPS/S.F. Downstream
Sect. At	I	Yes	-	8.24	49.0	8.56	.93
Elev. 758.0	IA	Yes	-	7.44	49.0	9.44	.16
Ht. = 95.0'	II	Yes	-	17.29	49.0	3.06	1.56
Base = 49.0'	III	Similar to Case II					
	IIIA	Similar to Case IIA					
	IV	Yes		17.25	49.0	3.13	1.41
	IVA	No	Yes	9.84	40.9	5.37	0
	V	Yes	-	12.72	49.0	3.22	.25
	VI	Yes	-	10.29	49.0	5.62	.02

(1) See Plates 8, 11, and 12 for details.
(2) Factor of safety computed with cohesion value of 80 psi and coefficient of friction of 0.5.

2.3 Service Bridge Abutment

Access to the intake structure from the embankment is provided by the service bridge which is approximately 50 feet in length. The embankment end of the bridge is supported by a gravity type concrete abutment with spread footings.

The abutment has a height of 13 feet, a base length of 10.83 feet and a base width of approximately 17 feet.

The loading conditions which were considered are as follows:

Case I. Dead load reaction of bridge. No water. Drained backfill.

Case II. Dead load reaction of bridge. Water level at spillway crest. Uplift.

Case III. Dead load reaction of bridge. Floodwater level to El. 822.0. Uplift.

Case IA, IIA. Same as Case I or II plus earthquake.

For Load Cases 1 through III, stability criteria are satisfied if the resultant falls within the middle third of the base and the factor of safety against sliding is greater than 1.5. For Load Cases IA and IIA, stability criteria are satisfied if the resultant stays within the base and the factor of safety against sliding is greater than 1.5. Allowable foundation pressures are not to be exceeded for any load cases.

Table 3 contains the results of the stability analysis of the service bridge abutment. All stability criteria are satisfied.

TABLE 3

STABILITY ANALYSIS OF SERVICE BRIDGE ABUTMENT

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Fill KIPS/S.F. Upstream	Bearing Pressure on Fill KIPS/S.F. Downstream
Typical Sect.	I	Yes	-	3.44	10.83	2.47	1.28
At Elev. 817.0	IA	Yes	-	2.39	10.83	2.93	.77
Ht. = 13.0'	II	Similar to Case I					
Base = 10.83'	IIA	Similar to Case IA					
	III	Yes	-	2.95	10.83	2.51	1.1

(1) See Plate 13 for details.
(2) Factor of safety computed with cohesion value of 0 and coefficient of friction of .45.

2.4 Access Bridge Abutment

Approach to the Barre Falls Dam is provided by an access bridge across the spillway channel which is approximately 95 feet in length. The ends of the bridge are supported by gravity type concrete abutments.

The section analyzed is triangular in shape, has a base length of 24.53 feet and height of 25.76 feet.

The loading conditions which were considered are as follows:

Case I. Dead load reaction of bridge. No water. Drained backfill.

Case II. Dead load reaction of bridge. Water level at spillway crest. Uplift.

Case III. Dead load reaction of bridge. Floodwater level to El. 822.0. Uplift.

Case IA, IIA. Same as Case I or II plus earthquake.

For Load Cases I through III, stability criteria are satisfied if the resultant falls within the middle third of the base and the factor of safety against sliding is greater than 1.5. For Load Cases IA and IIA, stability criteria are satisfied if the resultant stays within the base and the factor of safety against sliding is greater than 1.5. Allowable foundation pressures are not to be exceeded for any load cases.

Table 4 contains the results of the stability analysis of the service bridge abutment. All stability criteria are satisfied.

TABLE 4

STABILITY ANALYSIS OF ACCESS BRIDGE ABUTMENT

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Rock KIPS/S.F. Heel	Bearing Pressure on Rock KIPS/S.F. Toe
Typical Sect.	I	Yes	-	1.94	24.53	0.8	6.78
At Elev. 809.0	IA	Yes	-	2.53	24.53	1.2	6.38
Ht. = 25.76'	II	Identical to Case I					
Base = 24.53'	IIA	Identical to Case IA					
	III	Yes	-	1.5	24.53	0.07	7.03

(1) See Plate 7 for details.
(2) Factor of safety computed with cohesion value of 0 and coefficient of friction of 0.5.

2.5 Intake Channel Walls

The intake channel walls are a gravity type founded on bedrock. The left intake channel wall is approximately 36 feet long, triangular in shape, with an average base length of about 16.5 feet and height of 18.0 feet. The right intake channel wall is approximately 30 feet long, also triangular in cross-section, with an average base length of 13.5 feet and height of 18.0 feet. Both walls retain earthfill, non parallel to the flow into the intake structure and have a top elevation of 779.3.

As outlined in EM 1110-2-2400 in the section entitled "Approach Channel Walls," the loading conditions which were considered for analysis are as follows:

Case I. Channel empty. Backfill naturally drained above.

Case II. Partial sudden drawdown of reservoir from design flood level. Water in channel to drawdown elevation which may occur suddenly. fill submerged to profile reached during design flood, drained above.

Case III. Sudden rise of reservoir to design flood elevation. Water in channel to design flood elevation. Fill submerged to concurrent water surface in fill, naturally drained abnve.

Case IA. Same as Case I with earthquake load added.

For all load cases considered, stability criteria are satisfied if the resultant stays within the base, provided that allowable foundation pressures are not exceeded, and the factor of safety against sliding is greater than 1.5.

Table 5 contains the results of the stability analysis of the intake channel walls. All stability criteria are satisified for the two sections considered.

TABLE 5

STABILITY ANALYSIS OF INTAKE CHANNEL WALLS

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Rock KIPS/S.F. Heel	Bearing Pressure on Rock KIPS/S.F. Toe
Sect. At	I	Yes	-	23.3	13.5	.67	3.67
Sta. 3+88	II	No	Yes	11.5	11.1	0	4.31
Right Side	III	Yes	-	37.1	13.5	.4	2.16
Ht. = 18.0'	IA	Yes	-	17.9	13.5	.08	4.26
Base = 13.5'							
Sect. At	I	Yes	-	20.0	16.5	.95	4.13
Sta. 3+88	II	No	Yes	12.6	13.4	0	5.07
Left Side	III	Yes	-	31.8	16.5	.57	2.43
Ht. = 18.0'	IA	Yes	-	15.4	16.5	.27	4.81
Base = 16.5'							

(1) See Plate 10 for details.
(2) Factor of safety computed with cohesion value of 80 psi and coefficient of friction of 0.5.

2.6 Spillway Channel Walls

These channel walls are located just upstream and downstream from the spillway weir and they protect the dam during periods of spillway discharge. The walls are concrete gravity type walls founded on bedrock.

The section analyzed is approximately triangular in shape, has a base length of 8.3 feet, a height of 8.0 feet, and has sloping backfill.

The north wall at station 9+05 and the south wall at station 9+65 are similar in section and loading to the left intake channel wall at station 3+88. They were not reanalyzed since this section met all stability criteria.

As outlined in EM 1110-2-2400 in the section entitled, "Approach Channel Walls," the loading conditions which were considered for analysis of the spillway channel walls are as follows:

Case I. Channel empty. Backfill submerged to line of drains, naturally drained above.

Case II. Partial sudden drawdown of reservoir from design flood level. Water in channel to drawdown elevation which may occur suddenly. Fill submerged to profile reached during design flood, drained above.

Case III. Sudden rise of reservoir to design flood elevation. Water in channel to design flood elevation. Fill submerged to concurrent water surface in fill, naturally drained above.

Case IA. Same as Case I with earthquake load added.

For all load cases considered, stability critiera are satisfied if the resultant stays within the base, provided that allowable foundation pressures are not exceeded, and the factor of safety against sliding is greater than 1.5.

A summary of the stability analysis of the spillway channel walls is presented in Table 6. The critieria for overturning, sliding and foundation pressures are statisfied.

TABLE 6

STABILITY ANALYSIS OF CHANNEL WALLS

Section (1)	Loading Case	LOCATION OF RESULTANT In Middle Third	LOCATION OF RESULTANT In Base	Sliding Factor of Safety (2)	Length of Base in Bearing (ft)	Bearing Pressure on Rock KIPS/S.F. Heel	Bearing Pressure on Rock KIPS/S.F. Toe
Typical Sect.	I	Yes	-	61.8	8.3	.64	1.52
At Elev. 822.0	II	Yes	-	33.3	8.3	0	1.74
Ht. = 8.0'	III	Identical to Case II					
Base = 8.3	IA	Yes	-	27.4	8.3	.13	2.03

(1) See Plate 6 for details.
(2) Factor of safety computed with cohesion value of 80 psi and coefficient of friction of 0.5.

2.7 Conclusions

The following concrete structures at Barre Falls Dam were analyzed for stability: spillway weir, intake structure, service bride abutment, access bridge abutment, intake channel walls, and spillway channel walls.

All stability criteria for these structures have been satisified and there are no recommended remedial measures at the present time.

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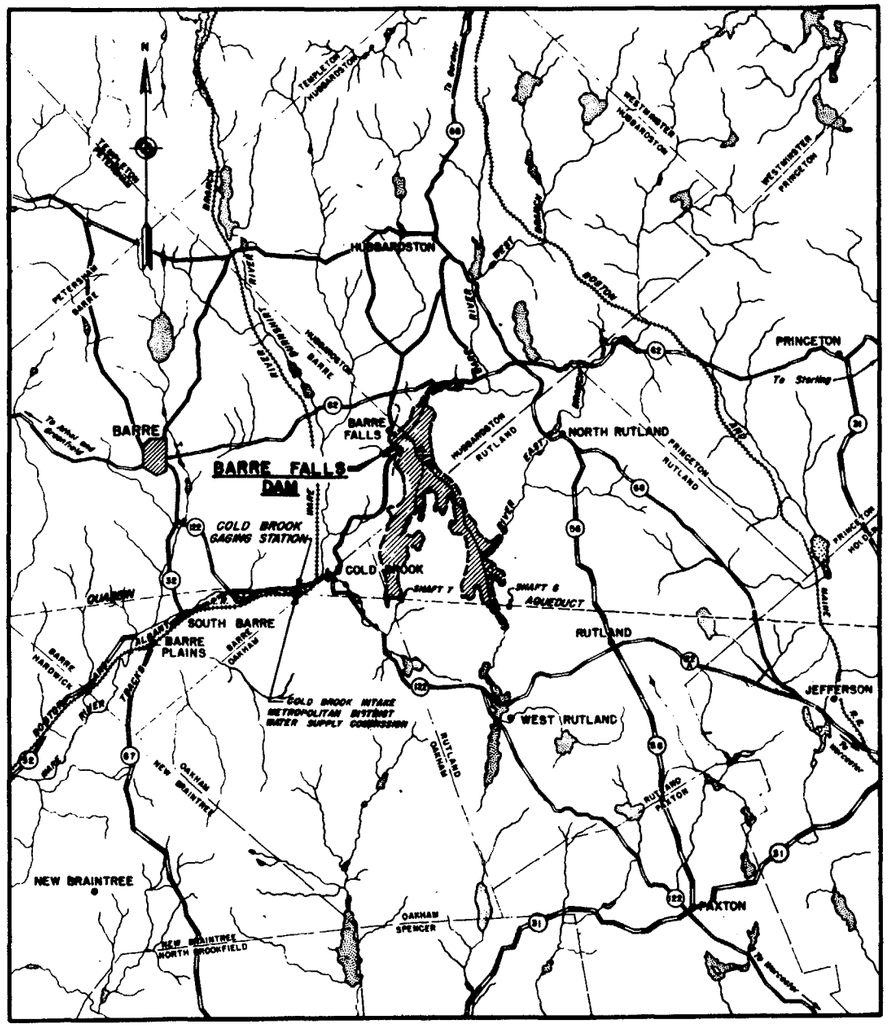

VICINITY MAP

SCALE IN MILES 0 1 2 3 MI

LEGEND

- State highways
- Railroads
- Flow line (At Spillway Crest)
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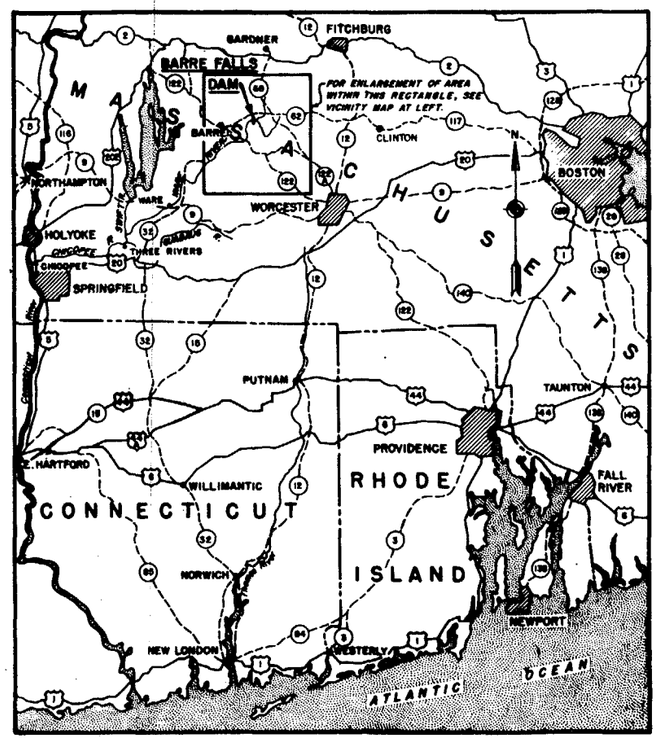
30	GATE STRUCTURE - STEEL REINFORCEMENT NO. 2	CT-I-3102
31	GATE STRUCTURE - STEEL REINFORCEMENT NO. 3	CT-I-3103
32	GATE STRUCTURE - STEEL REINFORCEMENT NO. 4	CT-I-3104
33	CONDUIT TRANSITION - CONCRETE DETAILS	CT-I-3105
34	CONDUIT - CONCRETE DETAILS	CT-I-3106
35	CONDUIT AND TRANSITION - STEEL REINFORCEMENT	CT-I-3107
△36	OUTLET PORTAL - CONCRETE DETAILS	CT-I-4143
37	GATE HOUSE - PLANS AND DETAILS	CT-I-3109
38	GATE HOUSE - ELEVATIONS	CT-I-3110
39	GATE HOUSE - ENTRANCE DETAILS	CT-I-3111
40	GATE HOUSE - DETAILS	CT-I-3112
41	GATE HOUSE - ROOF SLAB - STEEL REINFORCEMENT	CT-I-3113
42	SERVICE BRIDGE - PLAN AND SECTIONS	CT-I-3114
43	SERVICE BRIDGE - ABUTMENT DETAILS	CT-I-3115
44	GATE HOUSE - ELECTRICAL SYSTEM - CONDUIT LAYOUT	CT-I-3116
45	GATE HOUSE - ELECTRICAL SYSTEM WIRING DIAGRAM AND DETAILS	CT-I-3117
46	GATE STRUCTURE - ARRANGEMENT OF EQUIPMENT NO. 1	CT-I-3118
47	GATE STRUCTURE - ARRANGEMENT OF EQUIPMENT NO. 2	CT-I-3119
48	SLIDE GATES AND CONDUIT LINERS	CT-I-3120
49	EXTERIOR ELECTRICAL DETAILS	CT-I-3121
50	MISCELLANEOUS METALS - DETAILS NO. 1	CT-I-3122
51	MISCELLANEOUS METALS - DETAILS NO. 2	CT-I-3123
52	MISCELLANEOUS METALS - DETAILS NO. 3	CT-I-3124
53	TILE AND STAFF GAGES	CT-I-3125
54	UTILITY BUILDING - LOCATION PLAN AND DETAILS	CT-I-3126
55	UTILITY BUILDING - PLANS AND DETAILS	CT-I-3127
56	UTILITY BUILDING - ELEVATIONS	CT-I-3128
57	UTILITY BUILDING - SECTIONS AND DETAILS	CT-I-3129
58	UTILITY BUILDING - TRUSS AND MISCELLANEOUS DETAILS	CT-I-3130
59	UTILITY BUILDING - PLUMBING, HEATING AND ELECTRICAL	CT-I-3131
60	PUMP CHAMBER DETAILS	CT-I-3132
61	OPERATOR'S QUARTERS - LOCATION PLAN AND DETAILS	CT-I-3133
62	OPERATOR'S QUARTERS - FLOOR PLANS	CT-I-3134
63	OPERATOR'S QUARTERS - ELEVATIONS	CT-I-3135
64	OPERATOR'S QUARTERS - DETAILS	CT-I-3136
65	OPERATOR'S QUARTERS - PLUMBING, HEATING AND ELECTRICAL	CT-I-3137
66	DAM - PLAN OF FOUNDATION EXPLORATIONS	CT-2-1441
67	DAM - GEOLOGIC SECTIONS	CT-2-1442
68	DIKES - PLAN OF FOUNDATION EXPLORATIONS	CT-2-1443
69	DIKES - GEOLOGIC SECTIONS	CT-2-1444
70	BORROW AREAS - PLANS OF BORROW EXPLORATIONS	CT-2-1445
71	RECORD OF FOUNDATION EXPLORATIONS NO. 1	CT-2-1446
72	RECORD OF FOUNDATION EXPLORATIONS NO. 2	CT-2-1447
73	RECORD OF FOUNDATION EXPLORATIONS NO. 3	CT-2-1448
74	RECORD OF FOUNDATION EXPLORATIONS NO. 4	CT-2-1449
75	RECORD OF BORROW EXPLORATIONS	CT-2-1450
76	SOURCES OF MATERIALS INVESTIGATED FOR EMBANKMENTS	CT-2-1451
77	HYDROGRAPHS NO. 1	CT-5-1292
78	HYDROGRAPHS NO. 2	CT-5-1293



LOCATION MAP

SCALE IN MILES 0 50

LEGEND

- U.S. highways
- State highways
- State lines

Record Drawing
Contract No. DA-19-016-ENG-1359

REVISION	DATE	DESCRIPTION
△	11-26-56	File Number changed

CORPS OF ENGINEERS, U. S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION
BOSTON, MASS.

DES. BY W.E.B. | DR. BY [illegible] | CK. BY A.J.J.

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
PROJECT LOCATION AND INDEX
WARE RIVER MASSACHUSETTS
DATE FEB 1956

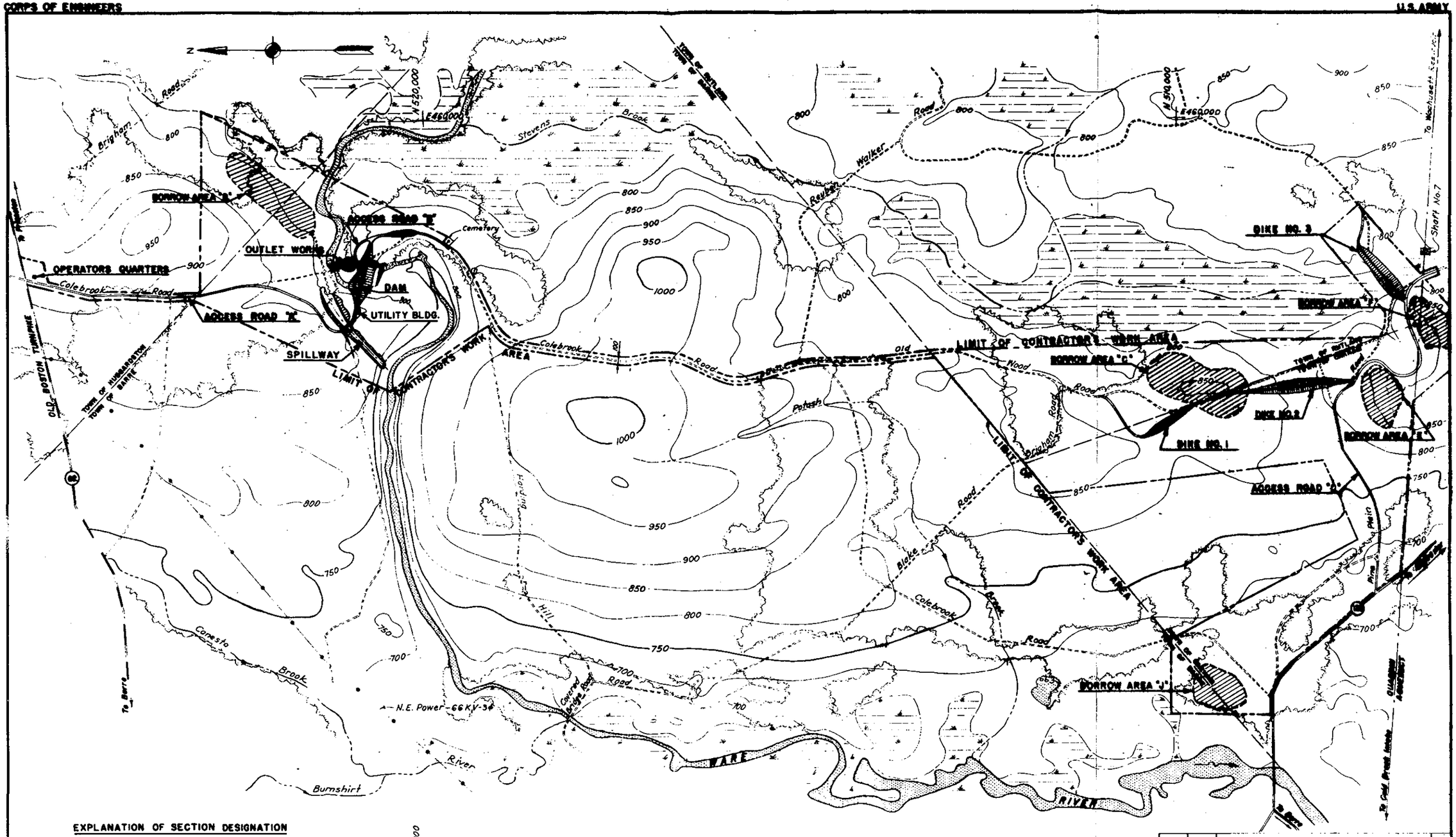
PROJECT ENGINEER
SUBMITTED BY
CHIEF ENGINEERING DIVISION
APPROVED
LT. COL., C.E. FOR THE DIVISION ENGINEER

SCALE AS SHOWN | SPEC NO CIV ENG-19-016-56-103
DRAWING NUMBER CT-1-3073
SHEET 1 OF 78

△

PLATE 1

CORPS OF ENGINEERS U.S. ARMY



EXPLANATION OF SECTION DESIGNATION

A section shown on the same sheet on which it is cut is designated by letter only.

A section shown on a sheet other than that on which it is cut is designated by a fraction. The numerator of the fraction is the section reference and the denominators are the sheet numbers on which the section is either cut or shown.

EXAMPLE

Section A is cut on Sheet No. 3 and the section is actually shown on Sheet No. 4. On Sheet No. 3 the section designation is $\frac{A}{4}$ and on Sheet No. 4 is $\frac{A}{3}$

N 520,000

E 450,000

LEGEND

- State Highways
- Existing gravel or dirt roads.
- Limit of contractor's work area.
- Limits of wooded area
- Limits of borrow areas

NOTES

Contour interval, 50 feet.

Elevations refer to Mean Sea Level Datum.

Grid system based on Mass. State Plane Coordinates.

Flow line at Spillway Crest El. 807.0 M.S.L.

Record Drawing
Contract No. DA-19-016-CIVENG-56-1354

SCALE 1" = 500'
500' 0 500' 1000'

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY WKD | DR. BY CMA | CK. BY WJJ

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
GENERAL PLAN
WARE RIVER MASSACHUSETTS

DATE FEB 1956

SCALE 1" = 500' SPEC. NO. CW-DAM-

DRAWING NUMBER
CT-1-3074

SHEET 2 OF 72

PLATE 2

CORPS OF ENGINEERS U.S. ARMY

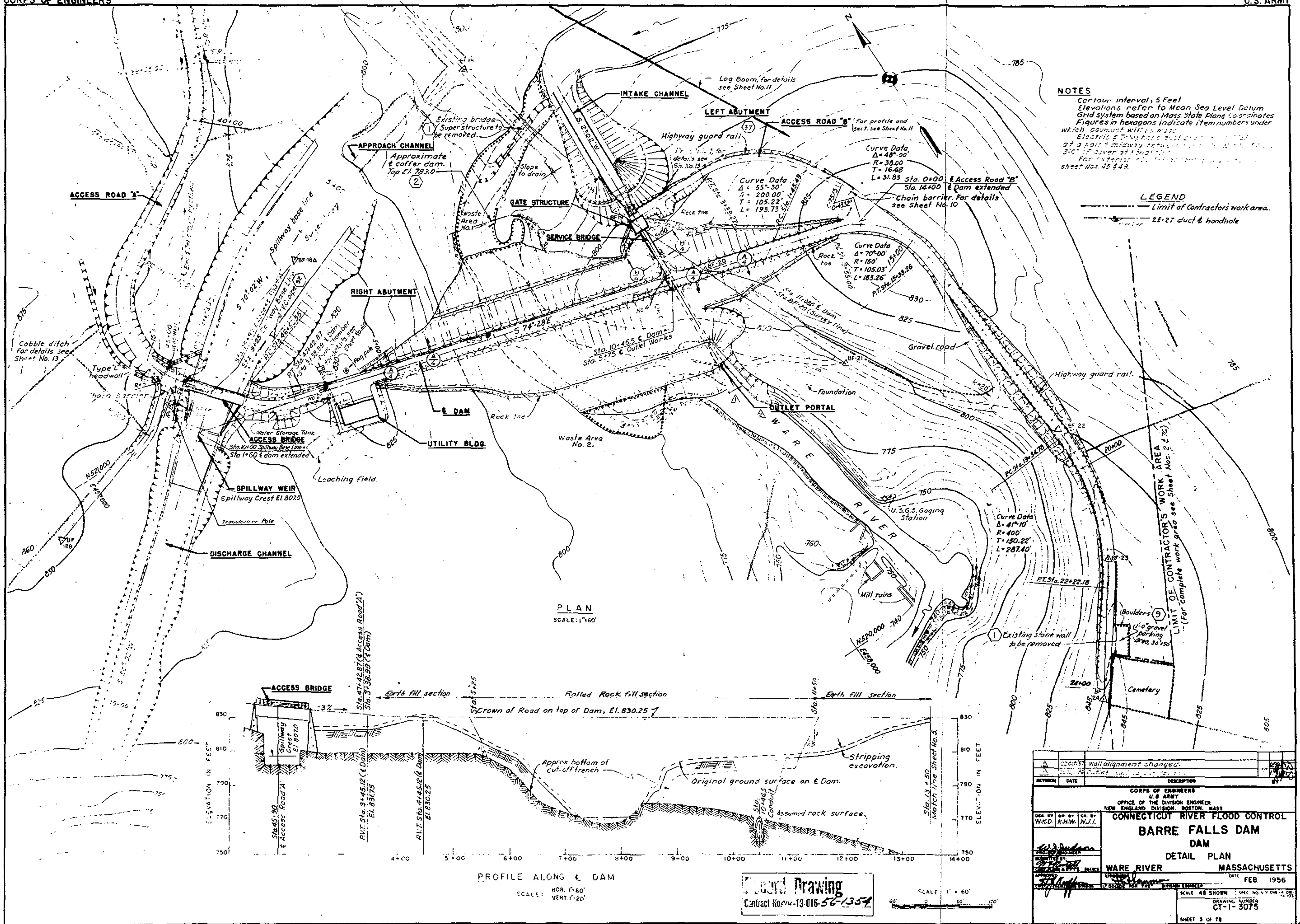
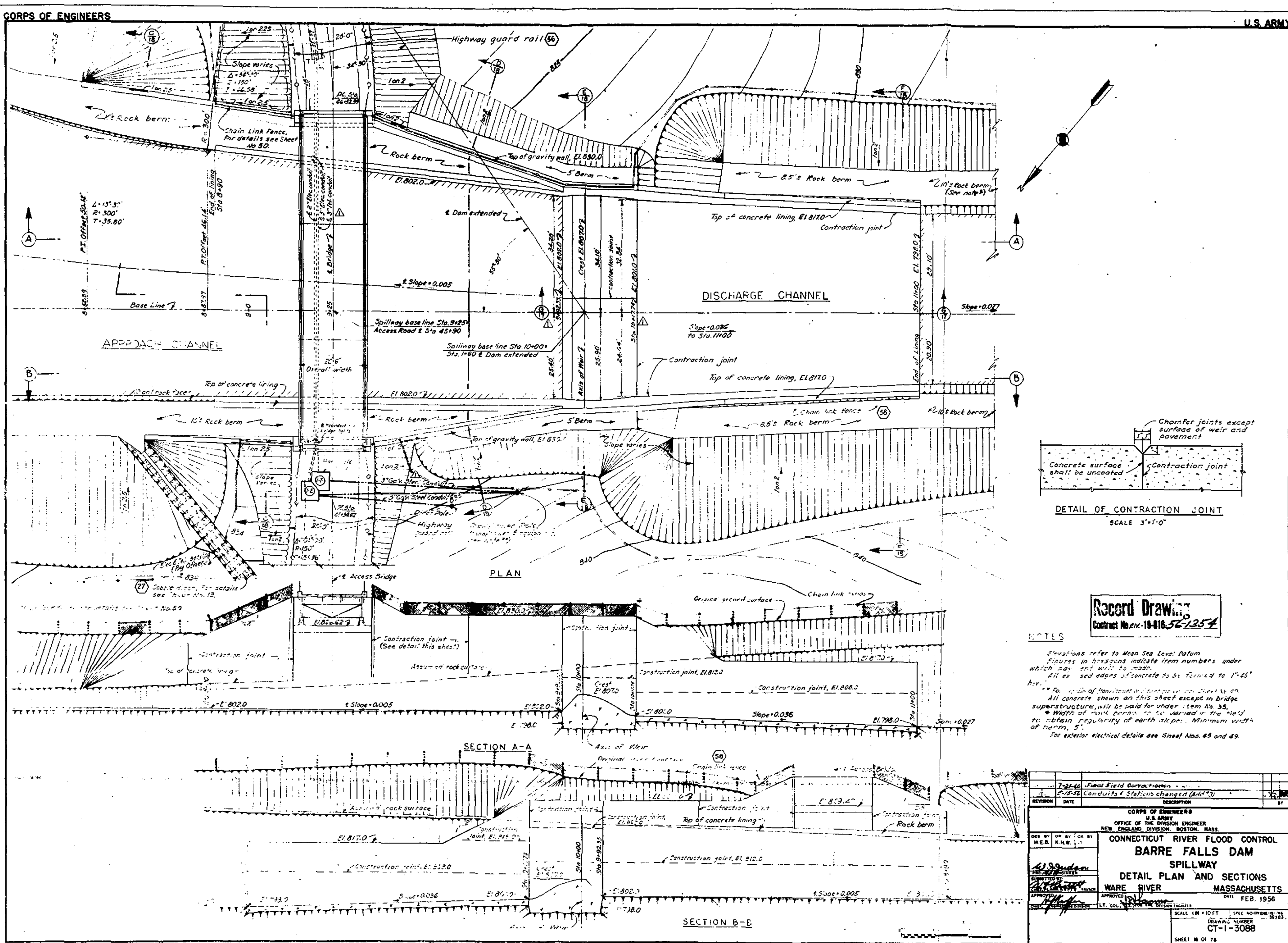


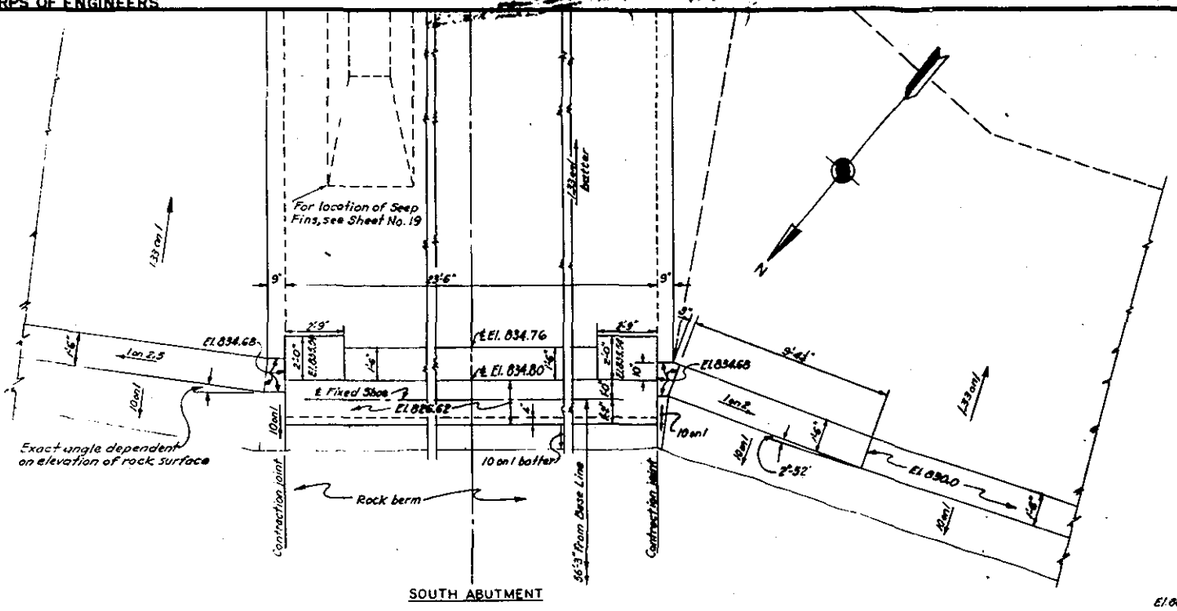
PLATE 3



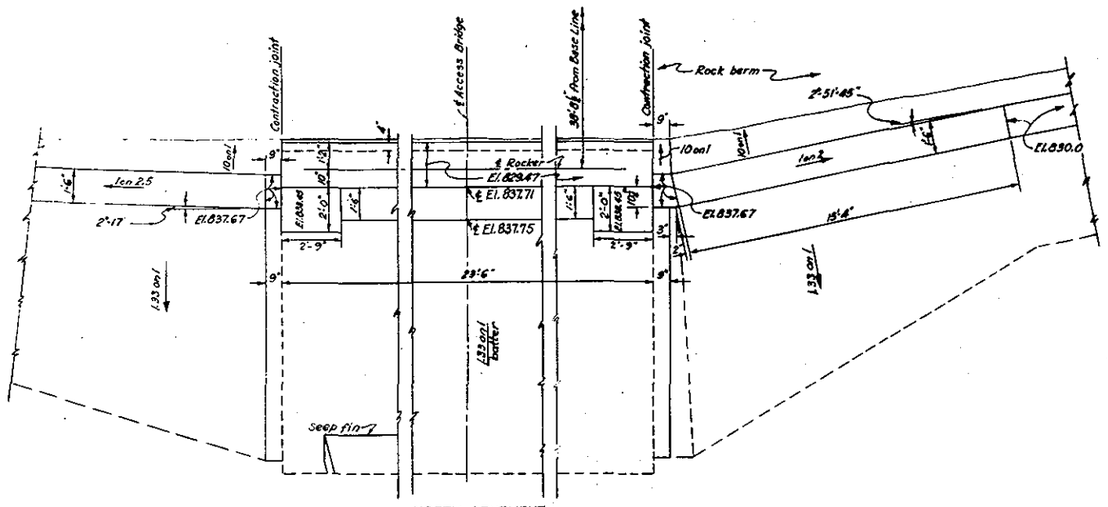
CORPS OF ENGINEERS
U.S. ARMY
Highway guard rail (56)
Slope varies
Chain Link Fence, For details see Sheet No. 50.
Rock berm
Top of gravity wall, El. 830.0
5' Berm
8.5'± Rock berm
10'± Rock berm (See note*)
℄ Dam extended
Top of concrete lining, El. 817.0
Contraction joint
DISCHARGE CHANNEL
APPROACH CHANNEL
Base Line
℄ Slope = 0.005
Spillway base line Sta. 9+25= Access Road ℄ Sta 45+90
Spillway base line Sta. 10+00= Sta. 1+60 ℄ Dam extended
Slope = 0.036 to Sta. 11+00
Slope = 0.027
Crest El. 807.0
Axis of Weir
End of Lining
Overall width
Top of concrete lining
El. 802.0
10'± Rock berm
Highway guard rail
℄ Access Bridge
PLAN
Chamfer joints except surface of weir and pavement
Concrete surface shall be uncoated
Contraction joint
DETAIL OF CONTRACTION JOINT
SCALE 3" = 1'-0"
Record Drawing
Contract No. CIV-19-016-56-1354
Original ground surface
Chain link fence
Contraction joint (See detail this sheet)
Assumed rock surface
Construction joint, El. 812.0
Construction joint, El. 808.0
Slope = 0.036
SECTION A-A
Axis of Weir
Rock berm
Construction joint, El. 812.0
Slope = 0.005
SECTION B-B
NOTES
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
All exposed edges of concrete to be formed to 1"-45° bev.
All concrete shown on this sheet except in bridge superstructure, will be paid for under item No. 35.
* Width of rock berms to be varied in the field to obtain regularity of earth slopes. Minimum width of berm, 5'.
For exterior electrical details see Sheet Nos. 45 and 49.
7-21-60 Final Field Corrections
5-15-56 Conduits & Stations changed (Add #3)
REVISION DATE DESCRIPTION BY
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.
CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
SPILLWAY
DETAIL PLAN AND SECTIONS
WARE RIVER
MASSACHUSETTS
FEB. 1956
DRAWING NUMBER CT-1-3088
SHEET 16 OF 78

PLATE 4 (16)

CORPS OF ENGINEERS U.S.ARMY



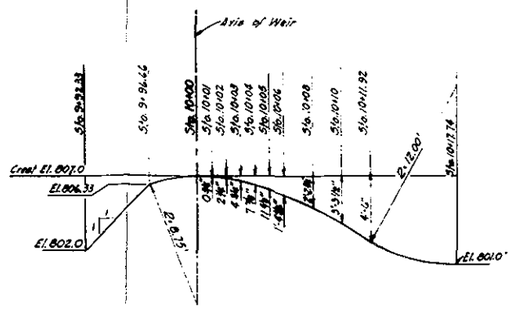
SOUTH ABUTMENT



NORTH ABUTMENT

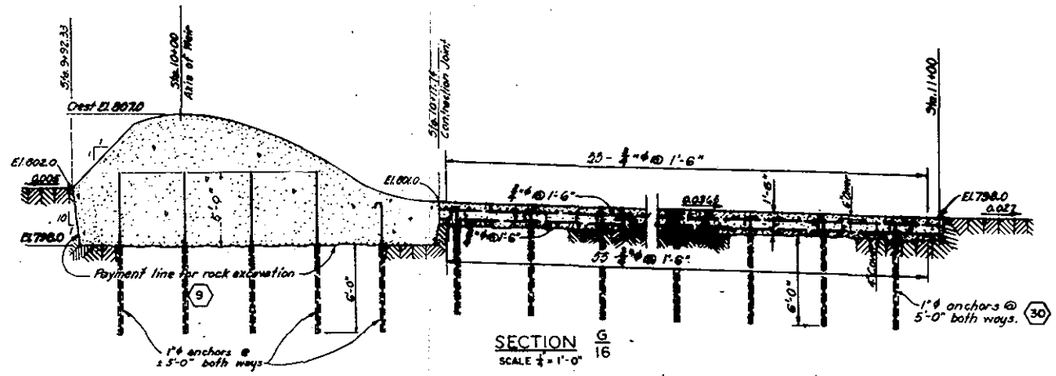
DETAIL OF WINGWALLS AT BRIDGE ABUTMENTS

SCALE: 3/8" = 1'-0"



SPILLWAY WEIR CURVATURE

SCALE 1/4" = 1'-0"



SECTION G/16

SCALE 1/4" = 1'-0"

DETAILS OF WEIR & CHANNEL PAVEMENT

NOTES

For general notes applying to this sheet see Sheet No. 16.

For details of bridge abutments see Sheets No. 19 & 20

For general notes applying to steel reinforcement see Sheet No. 27.

1"ø anchors to be grouted into 2" holes drilled 6'-0" into rock. Inclination of anchors to be determined in the field.

Record Drawing
Contract No. DA-19-016-56-1254

SCALE 1/4" = 1'-0"

SCALE 3/8" = 1'-0"

SCALE 3" = 1'-0"

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY	DR. BY	CH. BY
H.E.B.	K.H.W.	N.J.

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
SPILLWAY
CONCRETE DETAILS NO. 1
WARE RIVER MASSACHUSETTS

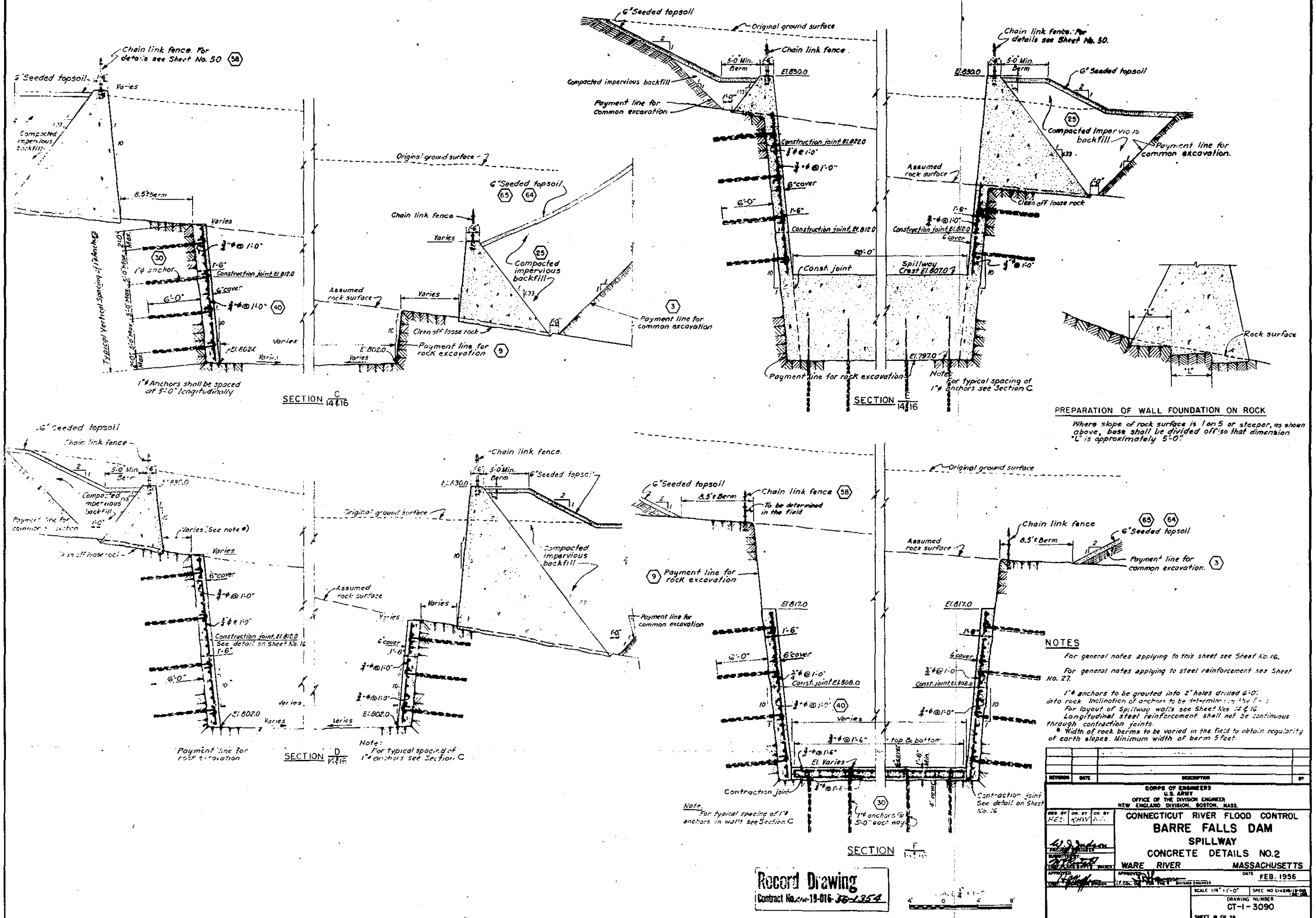
APPROVED: DATE FEB. 1956
LT. COL. CE, DIVISION ENGINEER

SCALE AS SHOWN | SPEC NO CIVENG-56-103

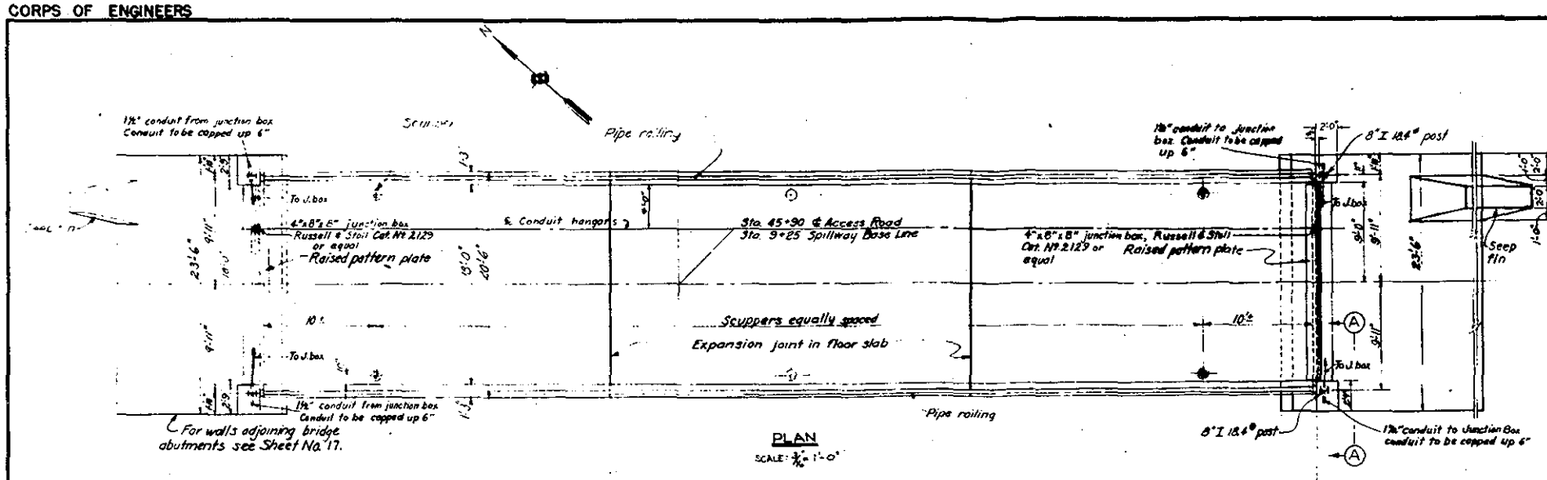
DRAWING NUMBER
CT-1-3089

SHEET 17 OF 78

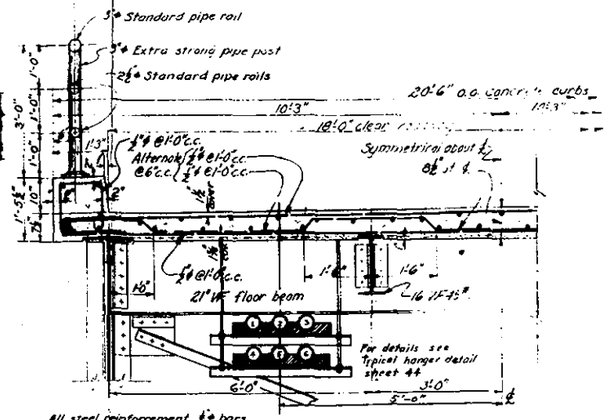
PLATE 5


Chain link fence. For details see Sheet No. 50 (58)
6" Seeded topsoil
Varies
Compacted impervious backfill
8.5'± Berm
Typical Vertical Spacing of 1" ϕ Anchors
1" ϕ anchor
3/4" ϕ @ 1'-0"
1'-6"
Construction joint, El. 812.0
6" cover
6'-0"
El. 802.0
1" ϕ Anchors shall be spaced at 5'-0" longitudinally
SECTION C 14 & 16
Original ground surface
Chain link fence
Assumed rock surface
Clean off loose rock
Payment line for rock excavation (9)
Payment line for common excavation (3)
6" Seeded topsoil (65) (64)
Compacted impervious backfill (25)
5'-0" Min. Berm
El. 830.0
Payment line for common excavation
Construction joint, El. 822.0
Const. joint
Spillway Crest El. 807.0
El. 797.0
Payment line for rock excavation
Note: For typical spacing of 1" ϕ anchors see Section C
SECTION E 14 & 16
Rock surface
PREPARATION OF WALL FOUNDATION ON ROCK
Where slope of rock surface is 1 on 5 or steeper, as shown above, base shall be divided off so that dimension "L" is approximately 5'-0".
Varies (See note *)
Construction joint, El. 812.0 See detail on Sheet No. 16
SECTION D 14 & 16
Note: For typical spacing of 1" ϕ anchors see Section C
To be determined in the field
El. 817.0
Const. joint El. 808.0
top & bottom
El. Varies
Contraction joint
Contraction joint See detail on Sheet No. 16
1" ϕ anchors @ 5'-0" each way (30)
Note: For typical spacing of 1" ϕ anchors in walls see Section C
SECTION F 14 & 16
NOTES
For general notes applying to this sheet see Sheet No. 16.
For general notes applying to steel reinforcement see Sheet No. 27.
1" ϕ anchors to be grouted into 2" holes drilled 6'-0" into rock. Inclination of anchors to be determined in the field.
For layout of Spillway walls see Sheet Nos. 14 & 16.
Longitudinal steel reinforcement shall not be continuous through contraction joints.
* Width of rock berms to be varied in the field to obtain regularity of earth slopes. Minimum width of berm 5 feet.
Record Drawing
Contract No. 19-016-56-1354
CORPS OF ENGINEERS U.S. ARMY
OFFICE OF THE DIVISION ENGINEER NEW ENGLAND DIVISION, BOSTON, MASS.
CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
SPILLWAY
CONCRETE DETAILS NO. 2
WARE RIVER MASSACHUSETTS
FEB. 1956
SCALE 1/4" = 1'-0"
DRAWING NUMBER CT-1-3090
PLATE 6

CORPS OF ENGINEERS — U.S. ARMY

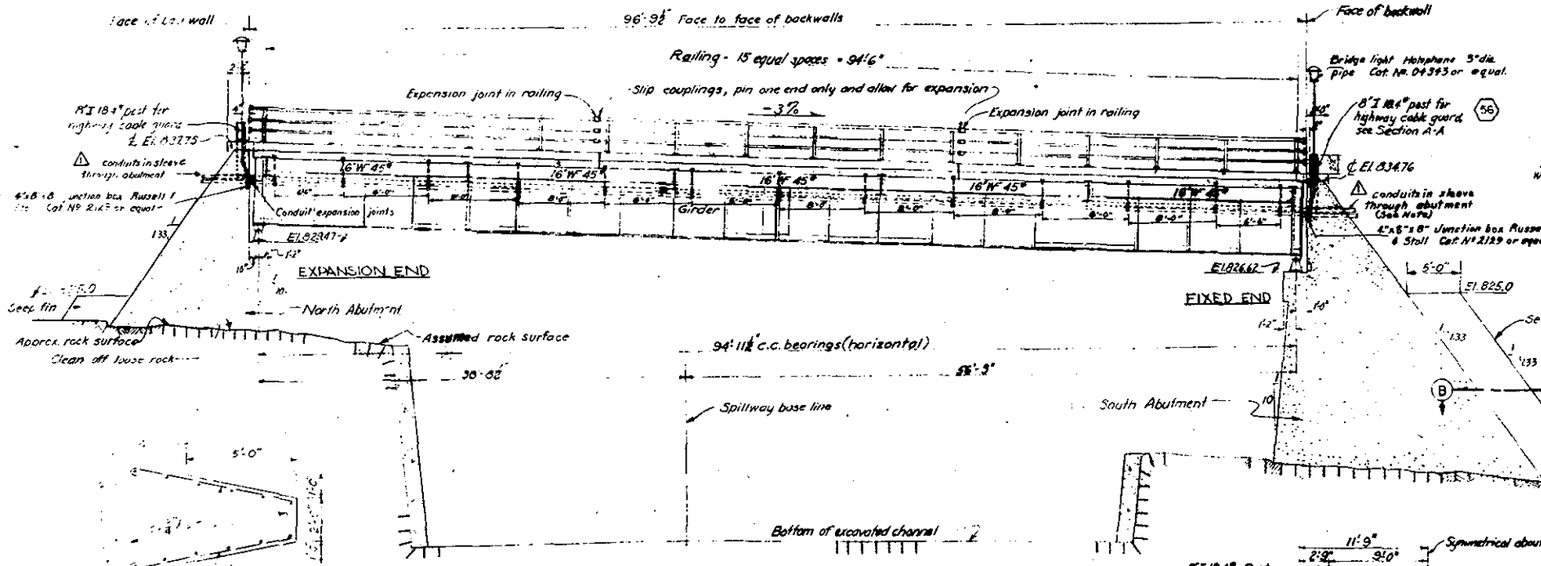


PLAN
SCALE: 1/8" = 1'-0"



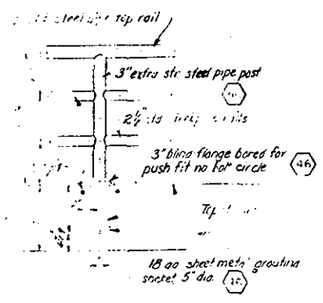
All steel reinforcement ½" ϕ bars spaced as indicated. See details this sheet for additional bars required in slab over floor beams.
Longitudinal steel reinforcement shall not be continuous through expansion joints in floor slabs or curbs.

CROSS SECTION
SHOWING SLAB REINFORCEMENT
SCALE: ½" = 1'-0"

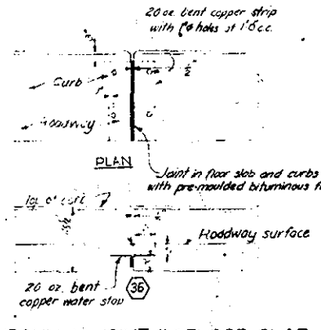


LONGITUDINAL SECTION ON ℄ BRIDGE
SCALE: 1/16" = 1'-0"

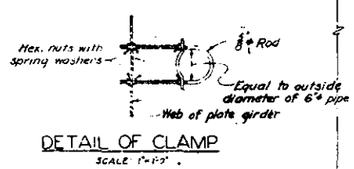
SECTION B-B
SCALE: 1/8" = 1'-0"



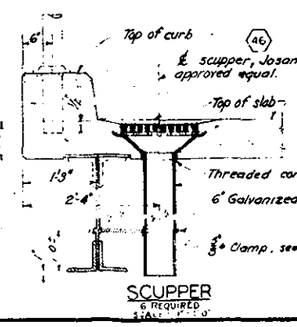
TYPICAL POST AND RAILING DETAILS
½" = 1'-0"



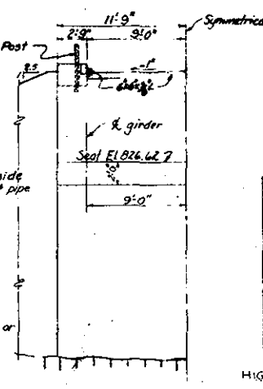
EXPANSION JOINT IN FLOOR SLAB
½" = 1'-0"



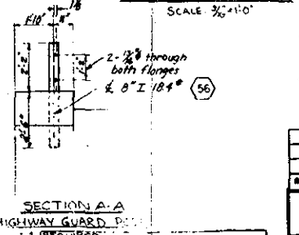
DETAIL OF CLAMP
SCALE: 1"=1'-0"



SCUPPER
6 REQUIRED
SCALE: 1"=1'-0"

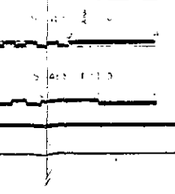


HALF ELEVATION
SOUTH ABUTMENT
SCALE: ½" = 1'-0"

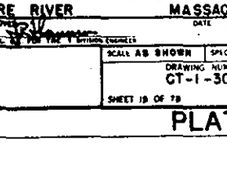


SECTION A-A
HIGHWAY GUARD POST
(4 REQUIRED)
SCALE: 1"=1'-0"

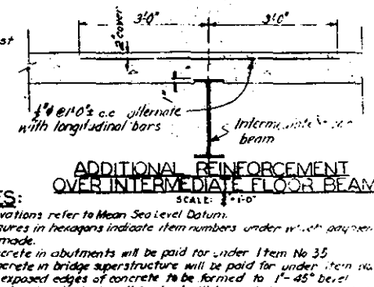
HALF ELEVATION
NORTH ABUTMENT
SCALE: ½" = 1'-0"



STEEL REINFORCEMENT
OVER END FLOOR BEAM
SCALE: ½" = 1'-0"



REINFORCEMENT AT
RAILING POSTS
SCALE: ½" = 1'-0"



ADDITIONAL REINFORCEMENT
OVER INTERMEDIATE FLOOR BEAMS
SCALE: ½" = 1'-0"

NOTES:
Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
Concrete in abutments will be paid for under Item No. 35.
Concrete in bridge superstructure will be paid for under Item No. 36.
All exposed edges of concrete to be formed to 1" - 45° bevel.
All structural steel on this sheet will be paid for under Item No. 42 except as otherwise indicated.
For general notes applying to steel reinforcement see Sheet No. 27.
For additional details of abutments, see Sheet No. 16.
For details of walls adjacent to abutments, see Sheets No. 16, 17 & 18.
⚠ For size of conduit, see Sheet No. 44.

REVISION	DATE	DESCRIPTION
⚠	5-16-56	Note added. Dims. changed (Adj #3).

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY	DR. BY	CK. BY
J.H.L.	J.H.L.	E.P.R.

CONNECTICUT RIVER FLOOD CONTROL

BARRE FALLS DAM
ACCESS BRIDGE
PLAN AND SECTIONS
WARE RIVER MASSACHUSETTS

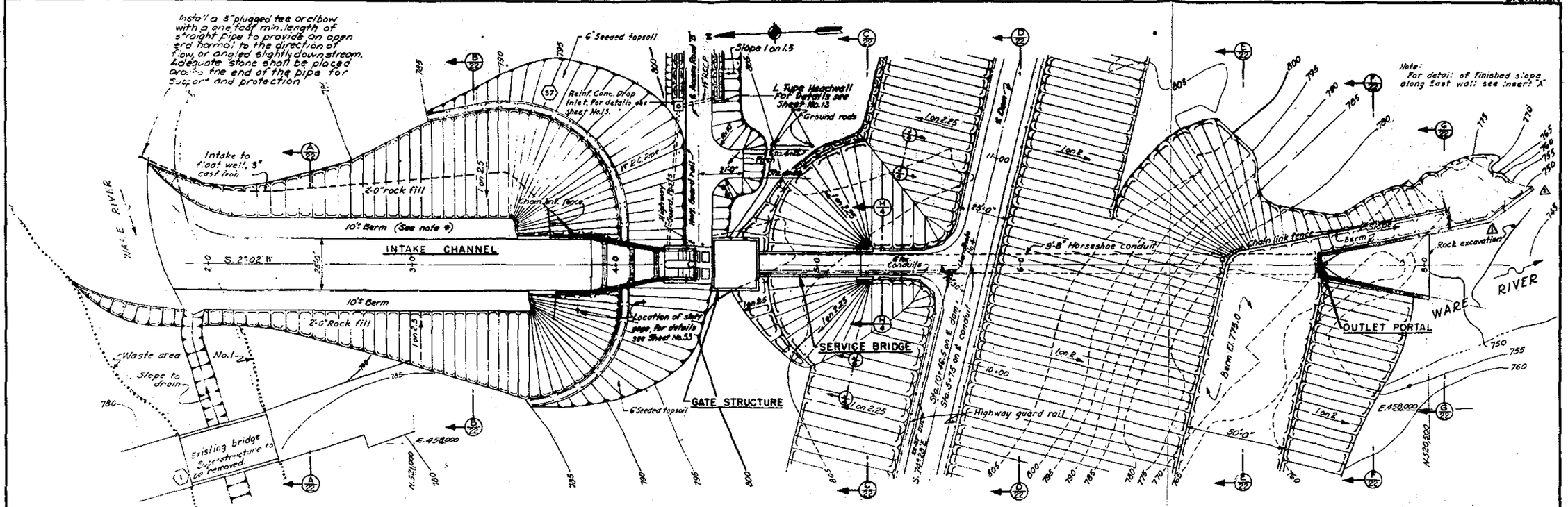
APPROVED: [illegible] DATE: FEB. 1956
Lt. Col., CE, Division Engineer

SCALE AS SHOWN
SPEC. NO. GIVEN: 19-016-56-1954
DRAWING NUMBER CT-1-3091
SHEET 19 OF 78

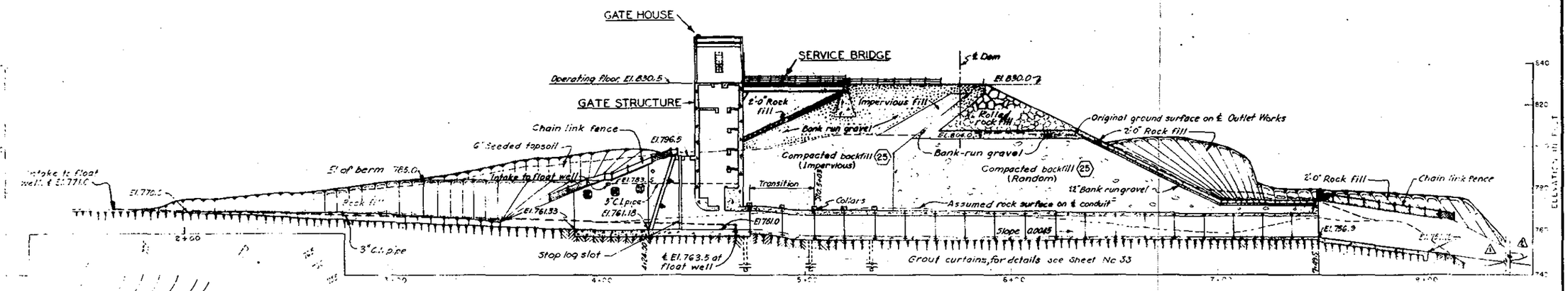
Record Drawing
Contract No. cwo-19-016-56-1954

PLATE 7 (19)

CORPS OF ENGINEERS — U.S. ARMY



PLAN
SCALE 1"=20'



PROFILE ALONG ℄ OUTLET WORKS
SCALE 1"=20'

SCALE: 1"=20'

LEGEND
EXISTING CONTOURS
FINISHED CONTOURS

NOTES
Contour interval, 5 feet.
Elevations refer to Mean Sea Level Datum.
Grid system based on Mass. State Plane Coordinates.
* Width of rock berms to be varied in the field to obtain regularity of earth slopes; minimum width of berm, 5'.

Record Drawing
Contract No. cw-19-018-56-1354

REVISION	DATE	DESCRIPTION
		Revised Final Field Corrections
2	22 Oct. 57	Wall alignment changed.
1	21 Nov. 56	Outlet wall layout revised

CORPS OF ENGINEERS
U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY | DR. BY | CK. BY

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
OUTLET WORKS
PLAN AND PROFILE
WARE RIVER — MASSACHUSETTS

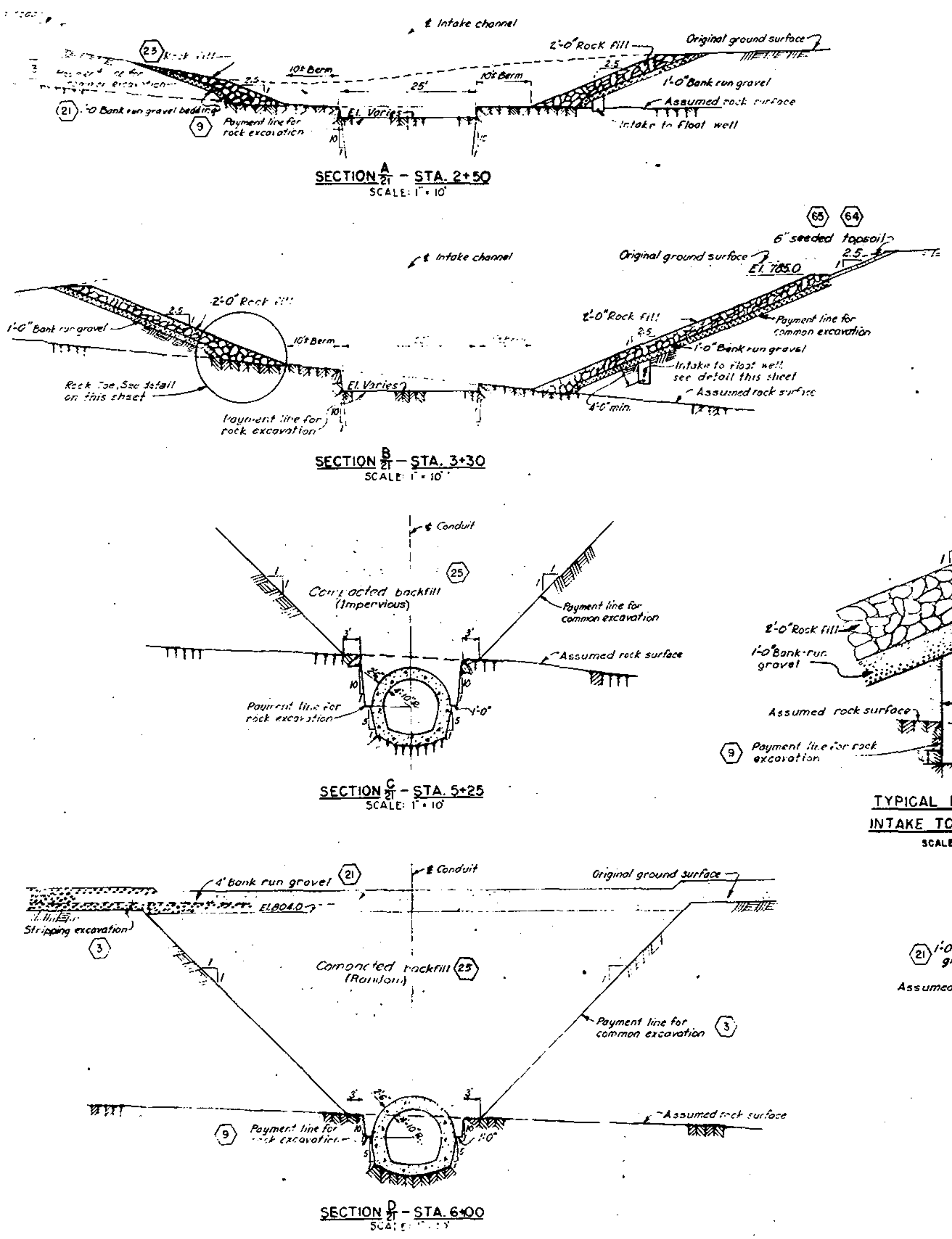
PROJECT ENGINEER
SUBMITTED BY: CHIEF, ENGINEERING BRANCH
APPROVED: CHIEF, ENGINEERING DIVISION
APPROVED: LT. COL., CE, FOR THE DIVISION ENGINEER
DATE FEB. 1956

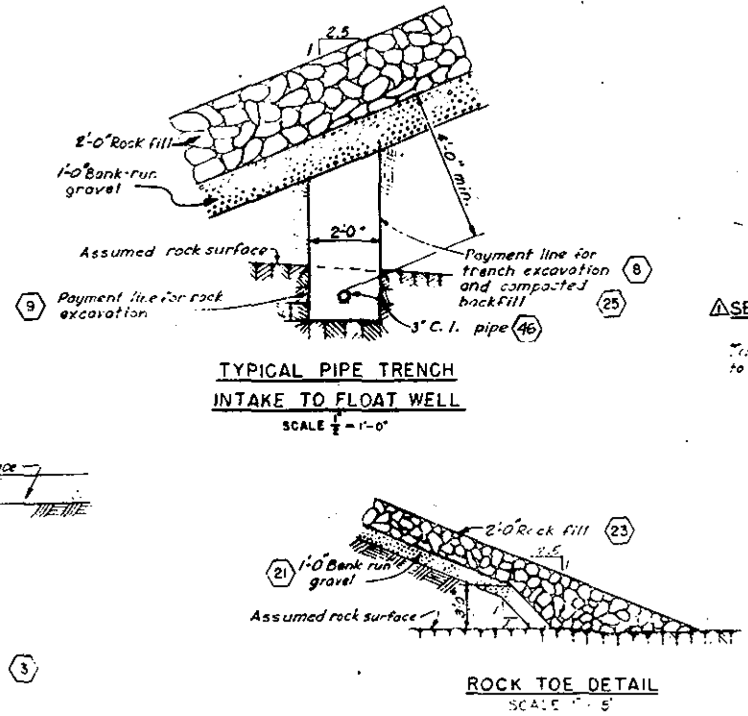
SCALE 1" = 20'-0" | SPEC. NO. EN-ENG-56-109
DRAWING NUMBER CT-1-3093
SHEET 21 OF 78

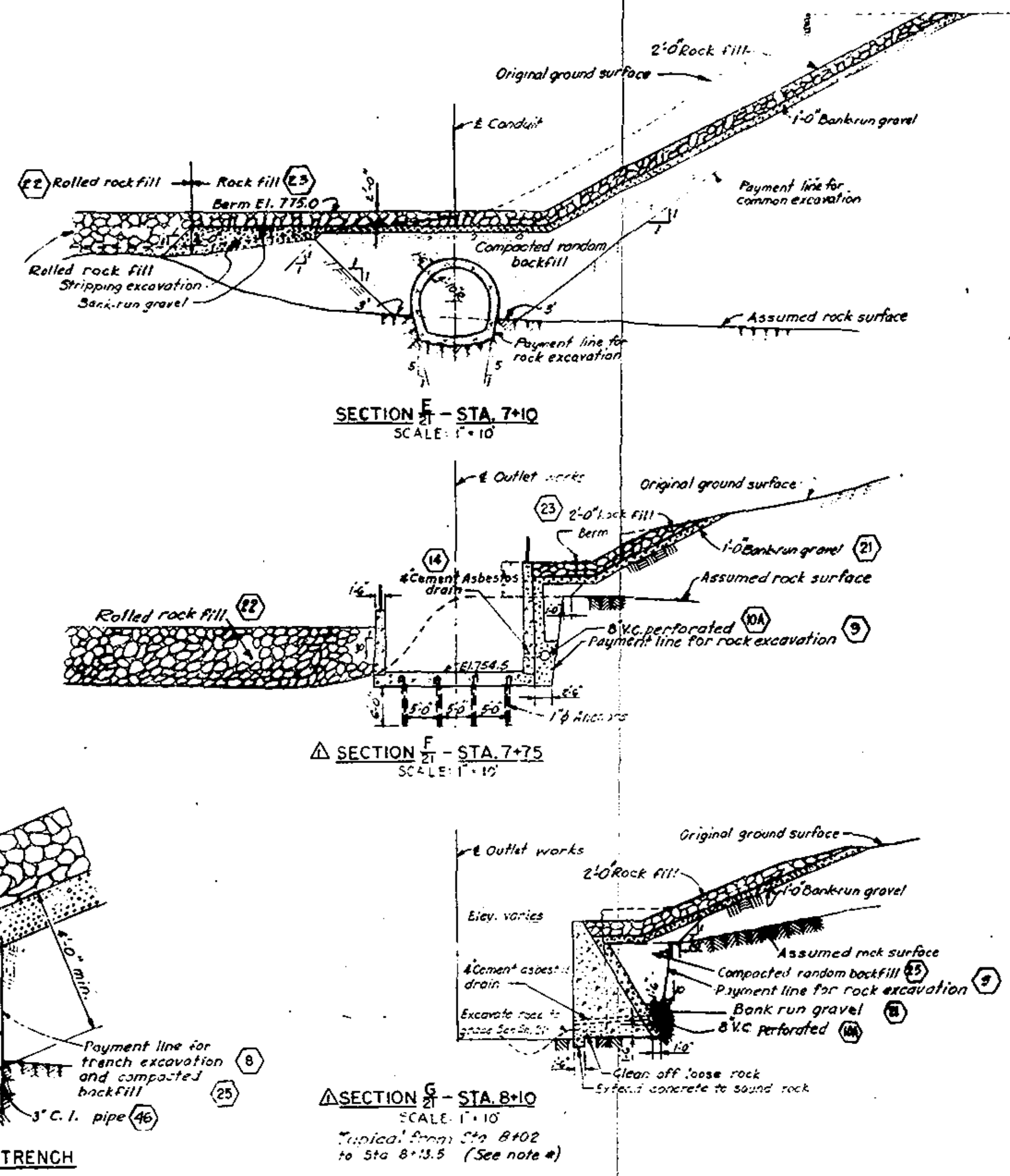
PLATE 8 (21)

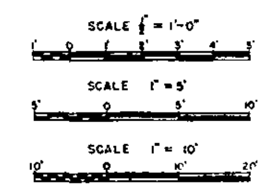
CORPS OF ENGINEERS

U.S. ARMY









NOTES

Elevations refer to Mean Sea Level Datum.

Figures in hexagons indicate item numbers under which payment will be made.

For typical section showing payment lines in rock and earth excavation see Sheet No. 15

⚠ * For wall and backfill details from Sta 8+13.5 to downstream end of wall see S. No. 56

Revision	Date	Description
⚠	26 Nov. 56	Note added and wall sections revised

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OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY W.K.D. | DR. BY K.H.Y. | CK. BY W.J.J.

CONNECTICUT RIVER FLOOD CONTROL

BARRE FALLS DAM
OUTLET WORKS
SECTIONS

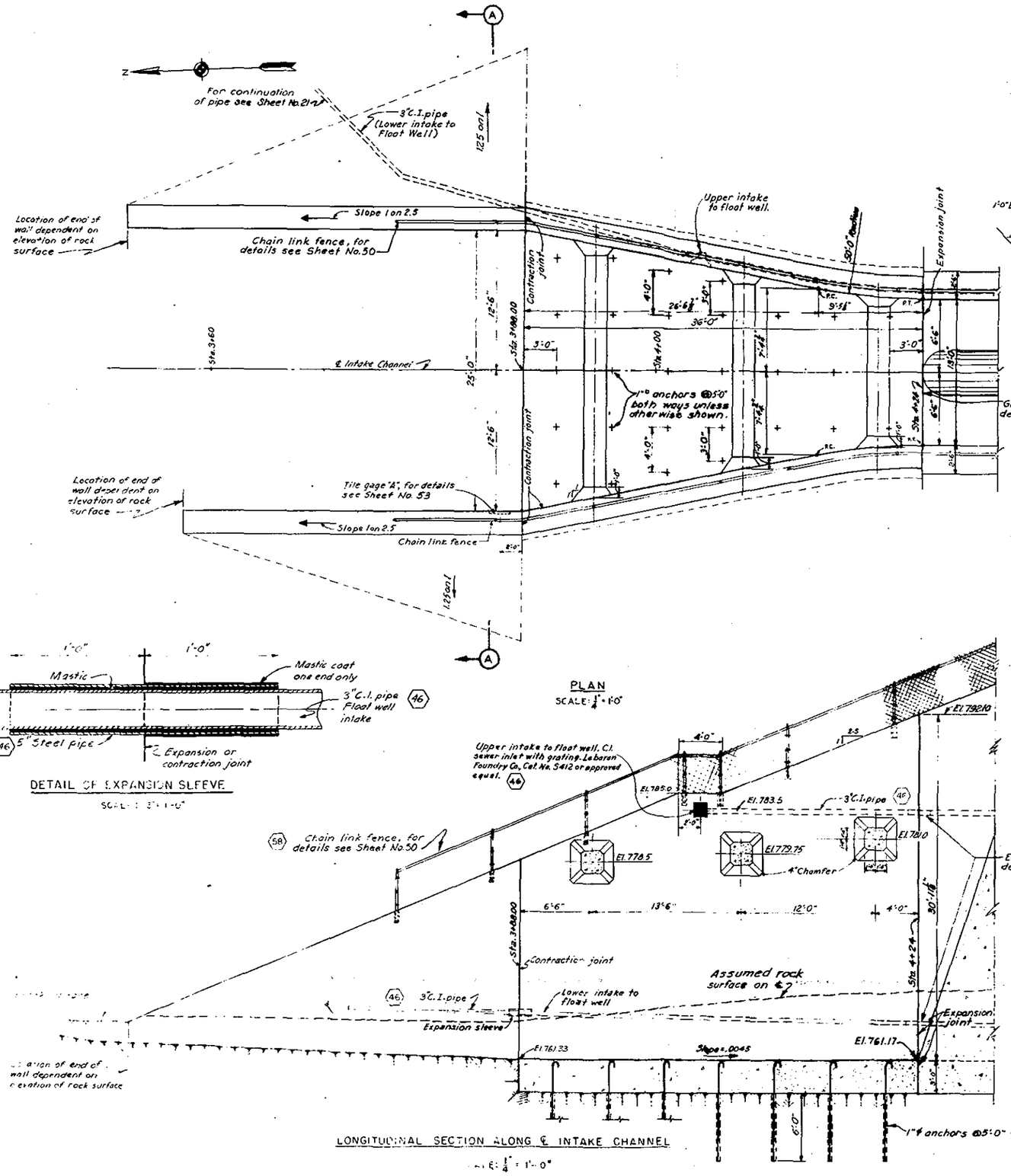
WARE RIVER — MASSACHUSETTS

SCALE AS SHOWN

DRAWING NUMBER CT-1-3094

SHEET 22 OF 79

CORPS OF ENGINEERS U.S. ARMY



NOTES

Elevations refer to Mean Sea Level Datum.
Figures in hexagons indicate item numbers under which payment will be made.
All exposed edges of concrete to be formed to 1"-45° bevel.
For general notes applying to steel reinforcement see Sheet No. 27
1"ø anchors to be grouted into 2" holes drilled 6'-0" into rock. Inclination of anchors to be determined in the field.
Concrete surface at contraction joints shall be uncoated and at expansion joints shall have ½" thickness of mastic.
Longitudinal steel reinforcement shall not be continuous through contraction and expansion joints.
All concrete in walls upstream of Sta. 4+24 will be paid for under Item No. 31
All concrete shown on this sheet between Sta. 3+88 and Sta. 4+24 will be paid for under Item Sta.

Record Drawing
Contract No. DA-19-015-56-1354

REVISION	DATE	DESCRIPTION	BY

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NEW ENGLAND DIVISION, BOSTON, MASS.

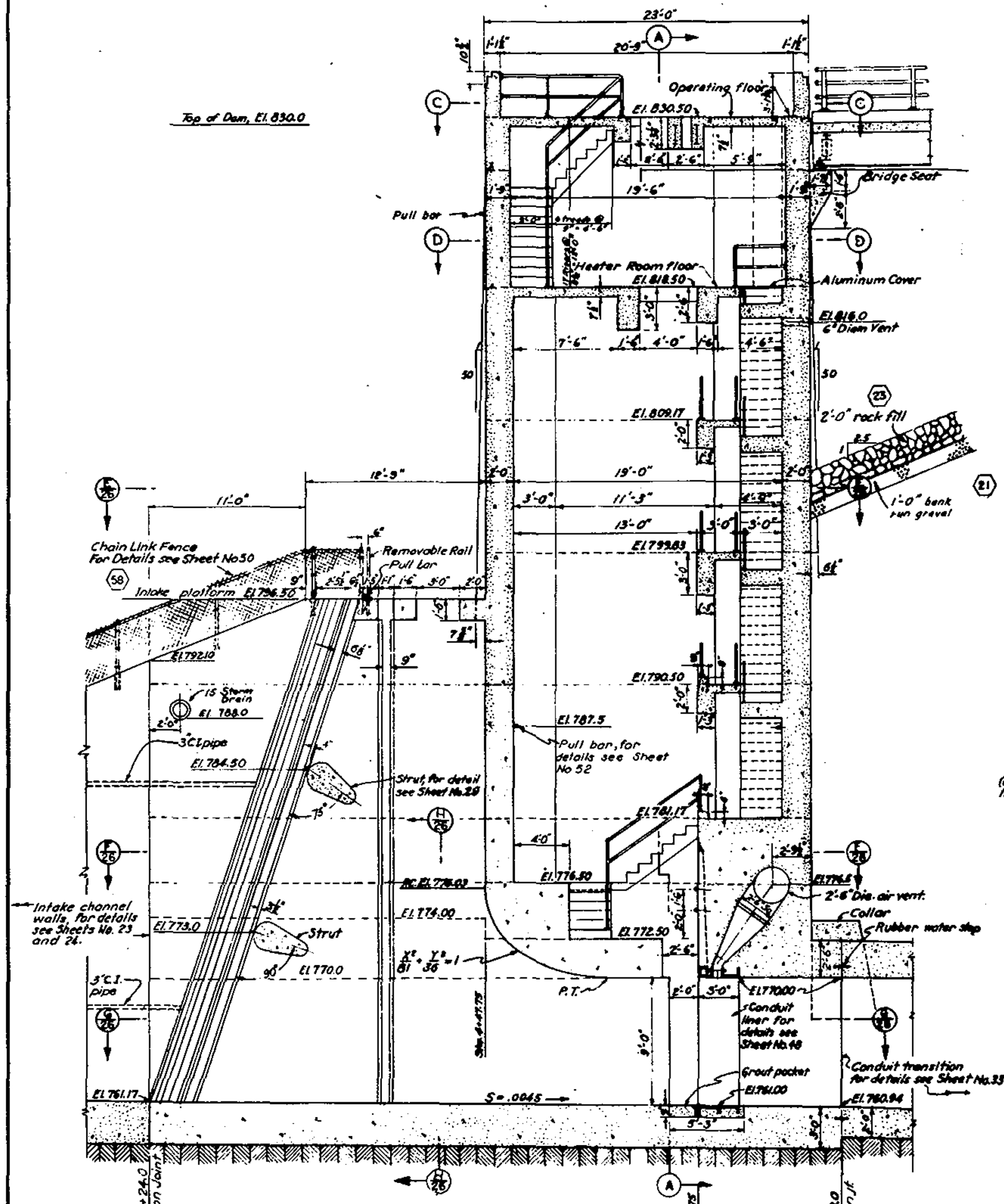
DES. BY WKD | DR. BY N.T. | CK. BY

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
INTAKE CHANNEL WALLS
CONCRETE DETAILS NO. I
WARE RIVER MASSACHUSETTS

PROJECT ENGINEER
SUBMITTED BY
CHIEF, ENGINEERING DIVISION
APPROVED
CHIEF, ENGINEERING DIVISION
APPROVED FOR THE DIVISION ENGINEER
LT. COL., CE
DATE FEB. 1956

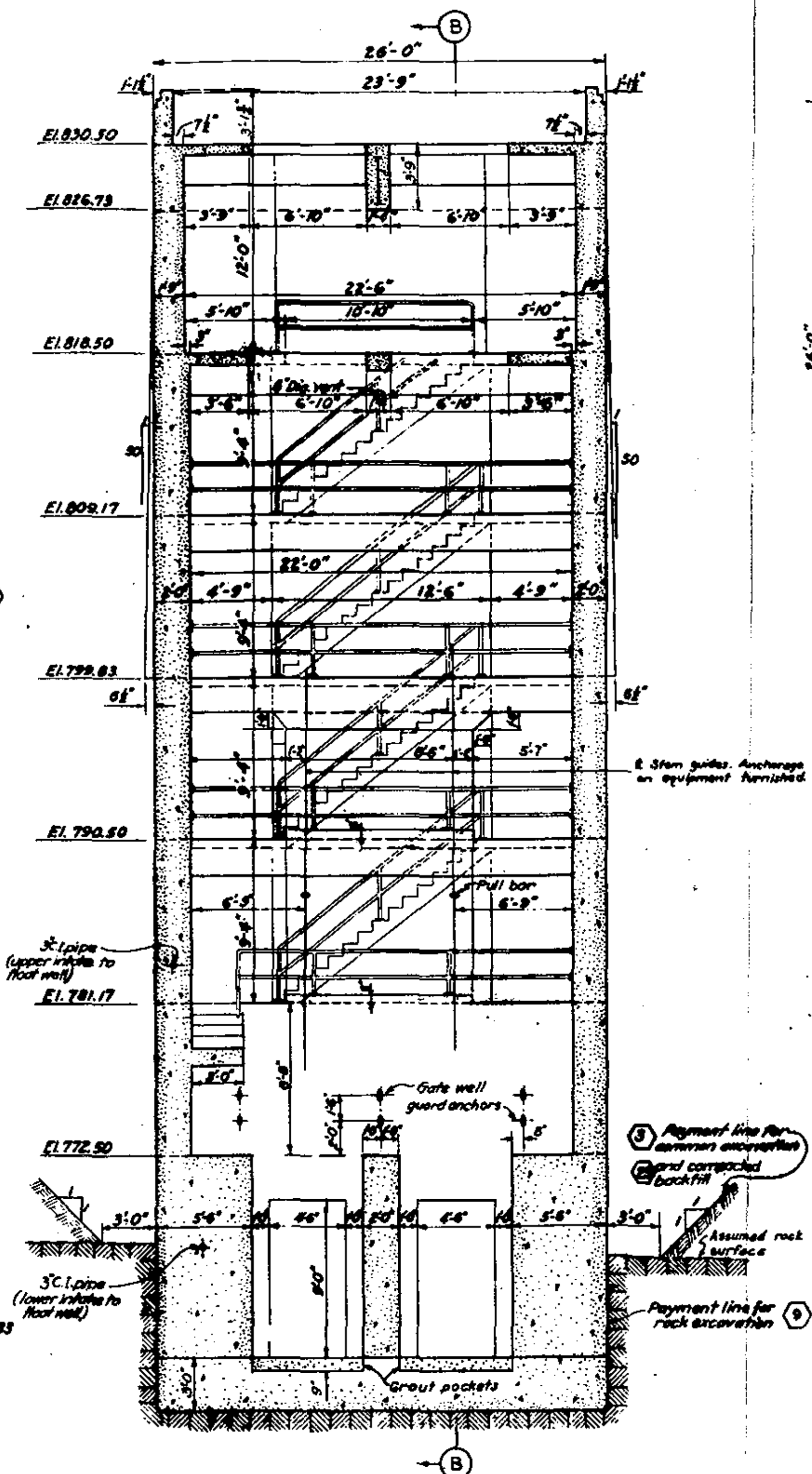
SCALE 1/4" = 1'-0" | SPEC NO EN-ENG-S-015 -58-108
DRAWING NUMBER CT-1-3095
SHEET 23 OF 78

PLATE 10 (23)



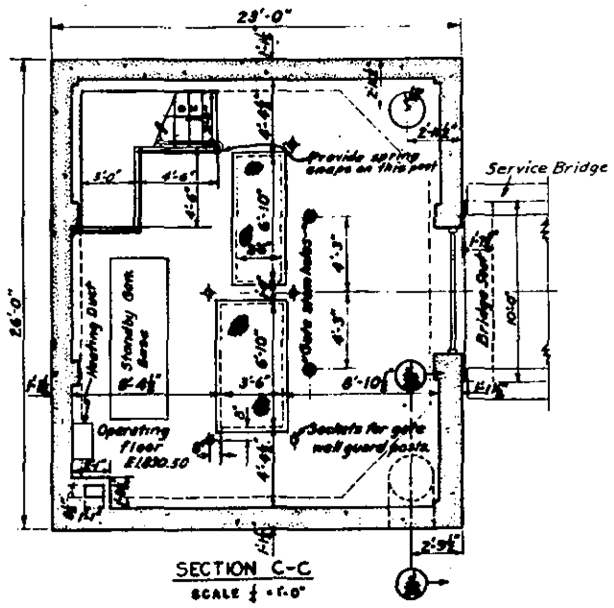
SECTION B-B

SCALE $\frac{1}{4}$" = 1'-0"



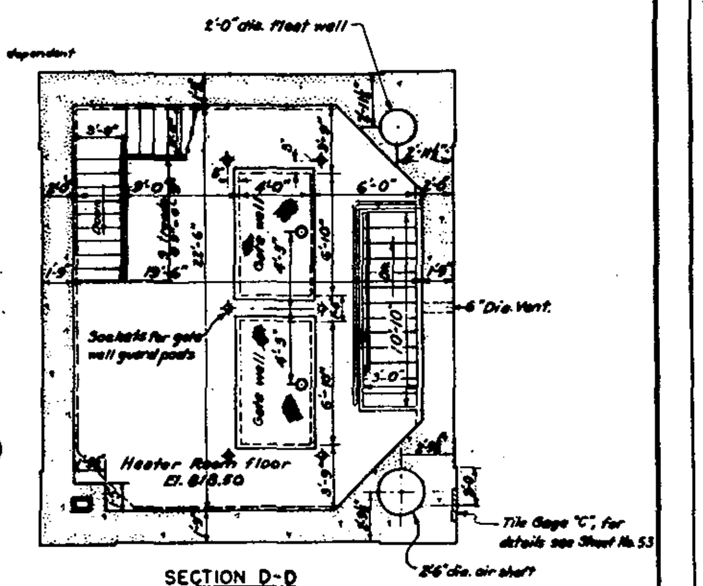
SECTION A-A

SCALE $\frac{1}{4}$" = 1'-0"



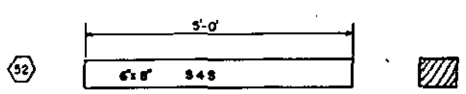
SECTION C-C

SCALE $\frac{1}{4}$" = 1'-0"



SECTION D-D

SCALE $\frac{1}{4}$" = 1'-0"



TIMBER STOP LOG (22 Required)

SCALE $\frac{3}{4}$" = 1'-0"

Record Drawing
Contract No. cw-19-016-56-1354

SCALE $\frac{1}{4}$" = 1'-0"

NOTES:

Elevations refer to Mean Sea Level Datum.

Figures in hexagons indicate item numbers under which payment will be made.

All exposed edges of concrete except beams to be formed to 1"-45° bevel.

Concrete surface at expansion joints shall have $\frac{1}{8}$" thickness of mastic.

All concrete shown on this sheet above El. 781.17 will be paid for under Item No. 33

All concrete shown on this sheet below El. 781.17, from Sta. 4+24 to Sta. 4+73, except in collars will be paid for under Item No. 32.

All concrete in collars will be paid for under Item No. 34.

For details of floor beams, stairs and platforms see Sheets No. 27 and 28

For details of miscellaneous metals shown on this sheet see Sheets 50, 51 and 52.

For details of steel reinforcement see Sheets No. 27 to 32 inclusive.

REVISION	DATE	DESCRIPTION	BY

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OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DSG. BY W.K.D. | DR. BY K.H.W. | CK. BY H.J.J.

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
GATE STRUCTURE
CONCRETE DETAILS NO. 1
WARE RIVER MASSACHUSETTS

LT. COL. C.E., FOR THE DIVISION ENGINEER

DATE FEB. 1956

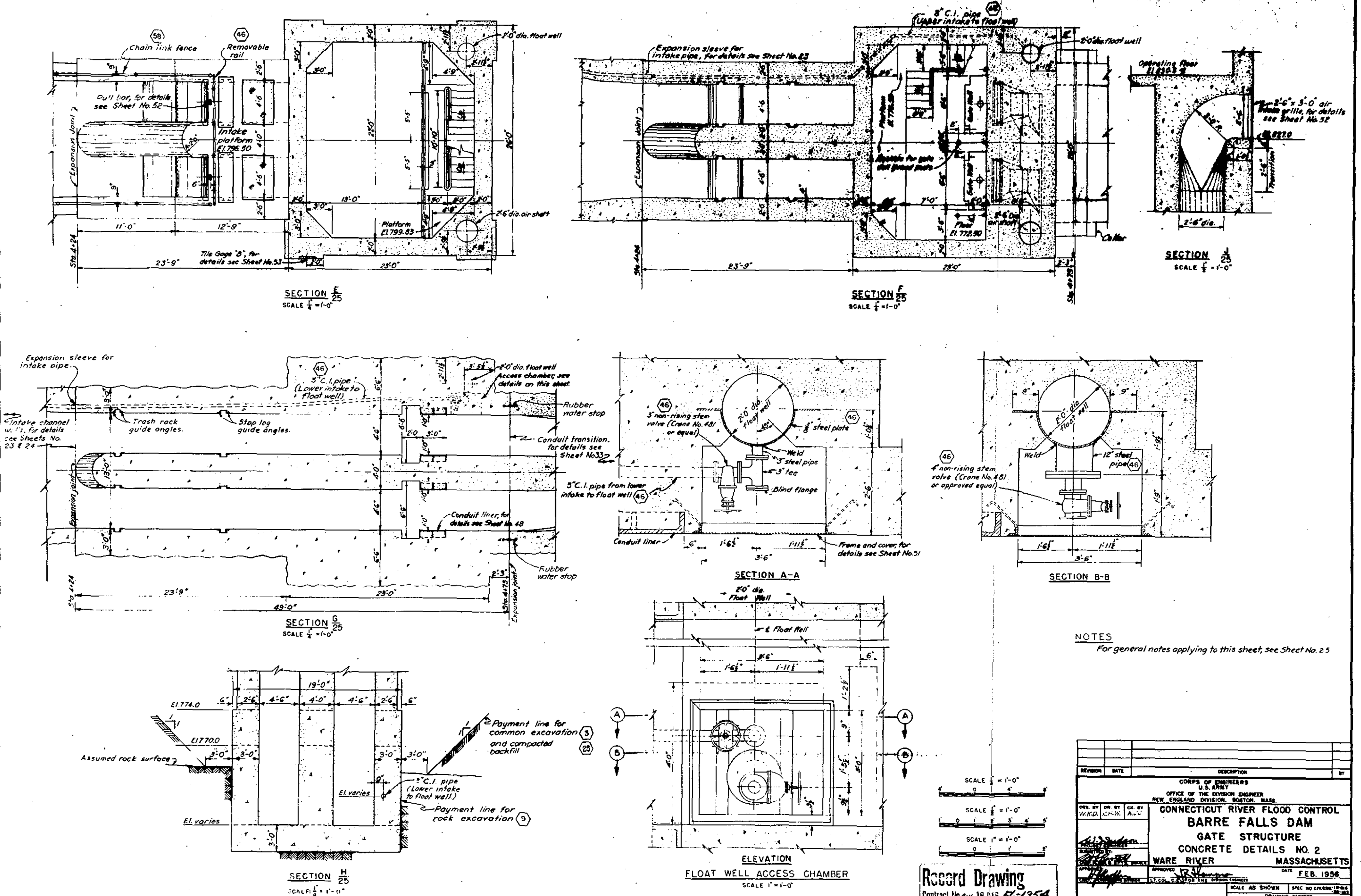
SCALE 1/8" = 1'-0" | SPEC. NO. CIVENG-19-016-56-103

DRAWING NUMBER CT-1-3097

SHEET 25 OF 70

CORPS OF ENGINEERS

U.S. ARMY



NOTES

For general notes applying to this sheet, see Sheet No. 25

REVISION	DATE	DESCRIPTION	BY

CORPS OF ENGINEERS
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OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
GATE STRUCTURE
CONCRETE DETAILS NO. 2
WARE RIVER MASSACHUSETTS

DATE FEB. 1956

SCALE AS SHOWN

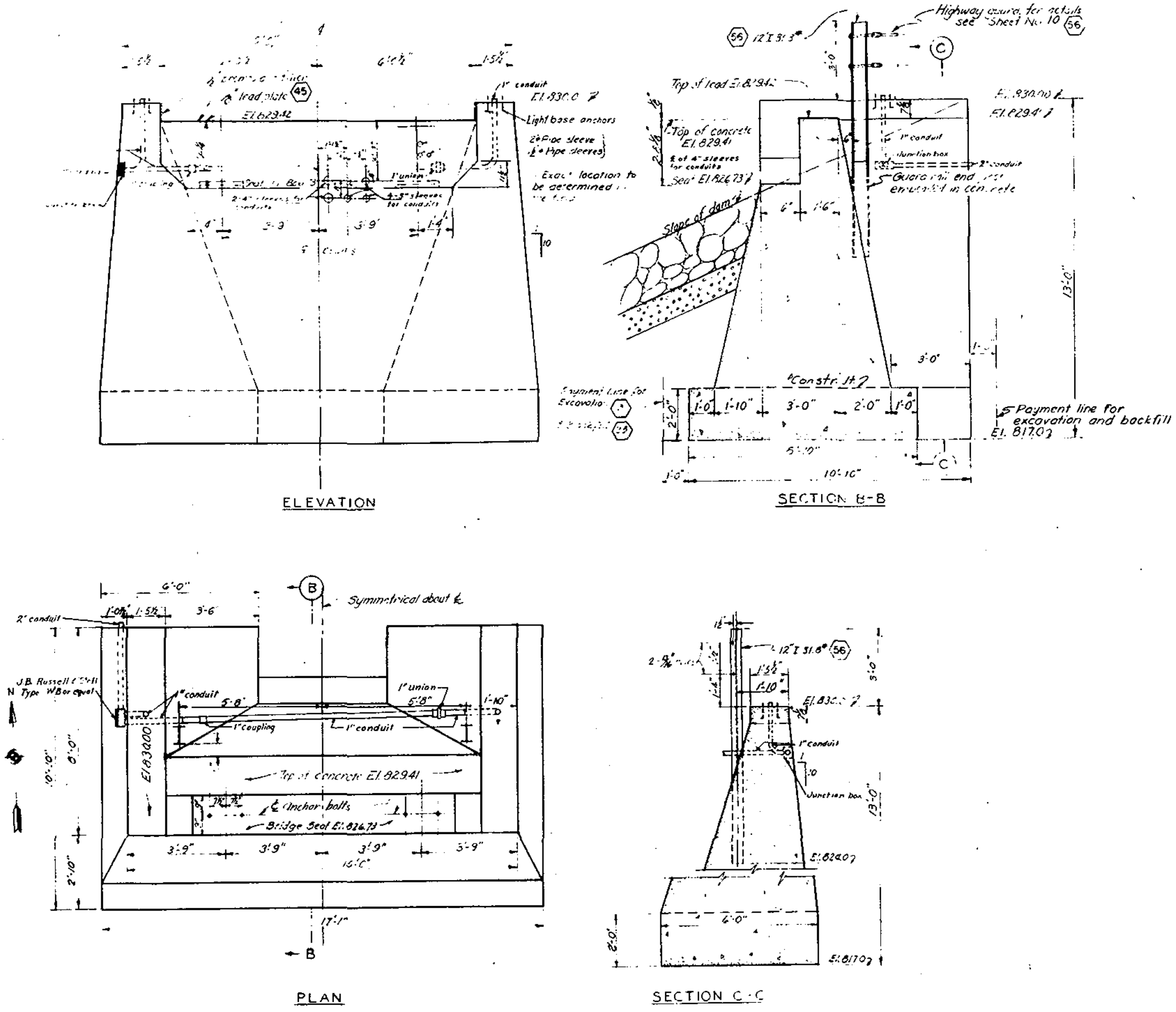
DRAWING NUMBER CT-1-3098

SHEET 26 OF 78

Record Drawing
Contract No. DA-19-016-56-1354

PLATE 12

26



ABUTMENT DETAILS
SCALE 1/4" = 1'-0"

NOTES

For general notes applicable to this Sheet see Sheet No. 42.
All concrete in abutment will be paid for under Item No. 37.
For locations of gasoline lines and electric conduits supported by service bridge see Sheets No. [illegible]

REVISION	DATE	DESCRIPTION	BY
	6-10-60	Final field corrections	

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U.S. ARMY
OFFICE OF THE DIVISION ENGINEER
NEW ENGLAND DIVISION, BOSTON, MASS.

DES. BY J.H.L. DR. BY J.H.L. CK. BY E.F.K.

CONNECTICUT RIVER FLOOD CONTROL
BARRE FALLS DAM
SERVICE BRIDGE
ABUTMENT DETAILS
WARE RIVER MASSACHUSETTS

DATE FEB. 1956
APPROVED LT. COL. C.E. FOR THE DIVISION ENGINEER
SCALE 1/8" = 1'-0"
DRAWING NUMBER CT-1-3115
SHEET 43 OF 78

Record Drawing
Contract No. civ-19-016-56-1354